
"It's all between my ears!"
Deficiencies in information processing in problematic drinkers with mild to borderline intellectual disability
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General introduction

There is a growing body of research on substance use (SU) and substance use disorders (SUD) among individuals with mild to borderline intellectual disability (MBID; IQ 50–85, American Psychiatric Association [APA], 2013). In fact, they have been identified as a risk group for more severe negative consequences of SU (Slayter, 2008) and for developing SUD (Burgard, Donohue, Azrin, & Teichner, 2000; McGillicuddy, 2006). This heightened risk for developing SUD seems to be the result of an accumulation of risk factors in individuals with MBID. For example, general risk factors for SUD such as adverse life events, inadequate coping strategies and a low socio-economical status are often more prevalent in individuals with MBID. In addition, risk factors associated with MBID itself (such as the desire to 'fit in', increased susceptibility to peer pressure and an inability to understand the consequences of SU; Didden, Embregts, Van der Toorn, & Laarhoven, 2009; Slayter & Steenrod, 2009; Taggart, McLaughlin, Quinn, & Milligan, 2006) and the relatively high prevalence of co-occurring use of prescribed psychotropic medication and psychiatric disorders further increase this risk (McGillicuddy, 2006; Slayter, 2010). Indeed, while it is generally accepted that the overall prevalence rates of SU are generally lower among individuals with MBID compared to the general population, their SU is often more problematic and the risk of developing SUD is higher (Burgard et al., 2000).

Despite this increasing attention for SU(D) among individuals with MBID, however, the current knowledge on SU(D) in individuals with MBID is scarce and tools for screening, assessing and treating SUD in this population are lacking. In addition, professionals in both intellectual disability services (ID services) as well as addiction medicine often report having insufficient knowledge and skills to adequately care for individuals with MBID and SUD. As a result, individuals with MBID often do not receive the required specialised care and do not always profit from treatment (e.g., Burgard et al., 2000; Cambell, Essex, & Held, 1994; Degenhardt, 2000). Thus, there is a high need for more research to improve the care and treatment of SU(D) in individuals with MBID (Carroll Chapman & Wu, 2012; Kerr, Lawrence, Darbyshire, Middleton, & Fitzsimmons, 2013).

This thesis addresses this need by studying the neuropsychological underpinnings of SUD, namely substance-induced disruptions in the motivational, reward and inhibitory control processes and subsequent deficiencies in information processing. Studying these deficiencies in information processing by developing and validating indirect or implicit measures for problematic drinkers with MBID could enhance professionals' understanding of SUD and provide new possibilities for the screening, assessment and treatment of SUD in this target group.

Dual process models of addiction

According to the APA (2013), SUD is characterised by a persistent desire to use substances and an inability to cut down or control SU, even in the face of negative consequences. Substances are used in larger amounts or over longer periods of time than was intended, despite (having knowledge of) the adverse physical, psychological, social and interpersonal problems related to SU or even in the face of these consequences. As Wiers and Stacy (2006, p. 292) note "… the typical problem in addiction is not that drug abusers do not realise that the disadvantages of continued drug use outweigh the advantages. The central paradox in addictive behaviours is that people continue to use substances even though they know the harm".

Dual process models of addiction (e.g., Bechara, Noel, & Crone, 2006; Strack & Deutsch, 2004; Wiers et al., 2007) have tried to explain this paradox. Although the terminology differs between the models, they all share the premise that behaviour is influenced by both automatic, implicit as well as controlled, explicit processes. Implicit processes (e.g., attention, evaluation of environmental cues, approach/avoidance behaviour) are considered to be spontaneous, fast, can sometimes occur outside of conscious awareness and cannot easily be controlled. Explicit processes (such as executive control and motivation), on the other hand, are deliberate, slow and require conscious awareness. Explicit processes moderate the influence of the implicit processes on behaviour. More specifically, those with strong executive control are thought to be more able to maintain long-term goals in active memory, suppress the influence of impulses conflicting with those goals and apply several strategies to resolve the goal conflict (Stacy, Ames, & Knowlton, 2004; Wiers & Stacy, 2006). Although IQ in itself is not described in the dual process models of addiction, it could be hypothesised that behaviour in those with weak executive control – such as individuals with MBID (Willner, Bailey, Parry, & Dymond, 2010a) – might be more strongly influenced by the implicit processes than in those with strong executive control.

As a result of long-term adaptations in the motivational, reward and inhibitory control processes related to chronic and/or excessive SU, the assumption is that implicit processes become stronger over time while the explicit processes become weaker (Wiers & Stacy, 2006). More specifically, the rewarding effects of substances and related stimuli become overvalued at the expense of other rewards (Hyman, Malenka, & Nestler, 2006; Nestler, 2005). They acquire 'incentive salience', meaning these stimuli seem attractive, 'grab attention' and elicit approach behaviour (Robinson & Berridge, 2003, 2008). These disruptions have been called cognitive biases. Several cognitive biases have been identified, including biases in attention, action tendencies and memory associations. Chronic and/or excessive SU also leads to a disrupted inhibitory control system, which is reflected in a smaller working memory capacity, difficulties in delaying gratification and less behavioural control in problematic drinkers (Dackis & O'Brien, 2005; Hyman et al., 2006). Together, these disruptions indicate a growing loss of control over SU (Koob, 2013;

Volkow, Wang, Tomasi, & Baler, 2013). Problematic drinkers have an impaired top-down control over their behaviour, which is increasingly influenced by automatic processes that cannot easily be controlled and sometimes occur outside of conscious awareness. This further deterioration of executive control as a result of SU, then, might explain the relative high risk for individuals with MBID to develop SUD after initial SU.

Cognitive biases

Cognitive biases have been studied extensively, using a variety of paradigms (for reviews, see Cox, Fadardi, & Pothos, 2006; Field & Cox, 2008; Field, Schoenmakers, & Wiers, 2008; Watson, De Wit, Hommel, & Wiers, 2012). They are usually studied with implicit measures, which provide indirect measures of attention or approach/avoidance tendencies derived from reaction times. Such measures are thought to tap into automatic cognitive processes (Wilson, Lindsey, & Schooler, 2000) and are thought to reduce self-representation influences or social desirability (Greenwald et al., 2002; Stacy & Wiers, 2010). Because these measures also do not rely on verbal capacity and are generally easy to conduct, these measures might be especially useful for individuals with MBID.

Examples of measuring approach/avoidance tendencies are the stimulus response compatibility task (SRC task; De Houwer, Crombez, Baeyens, & Hermans, 2001) and the approach avoidance task (AAT; Rinck & Becker, 2007). Results indicate that, relative to light drinkers, problematic drinkers are faster to approach alcohol-related stimuli and are slower to avoid these stimuli than neutral stimuli (e.g., Field, Caren, Fernie, & De Houwer, 2011; Sharbanee, Stritzke, Wiers, & MacLeod, 2013), which is indicative of an approach bias towards alcohol. It should be noted, however, that the presence of an approach bias towards alcohol has not consistently been found across studies. Three studies involving problematic drinkers receiving treatment have failed to find stronger approach tendencies for alcohol-related stimuli compared to neutral stimuli (Barkby, Dickson, Roper, & Field, 2012; Spruyt et al., 2013; Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011).

With regard to the attentional bias, two of the most widely used tasks are the addiction Stroop task (Stroop, 1935) and the visual dot probe task (VDP; MadLeod, Mathews, & Tata, 1986). Using these tasks, problematic drinkers have been shown to be slower in naming the colour of alcohol-related words compared to neutral words (for a review, see Cox et al., 2006) and to respond quicker to dot probes replacing alcohol-related pictures compared to neutral pictures (Field & Cox, 2008), suggesting an attentional bias towards alcohol. Because reaction times provide a rough, indirect measure of attention selection and allocation, a more recent development is the use of eye tracking methodology. Patterns in eye fixations, fixation duration and latency, eye movements (saccades) and pupillary responses are seen as direct manifestations of attention (Henderson, 2003). Research using eye tracking methodology has revealed that problematic drinkers direct their attention towards alcohol-related pictorial stimuli more often and maintain their gaze on these stimuli longer than light drinkers (Ceballos et al.,

2009; Friese et al., 2010; Miller & Fillmore, 2010). As with the approach bias towards alcohol, the presence of an attentional bias towards alcohol seems to depend on patient characteristics: problematic drinkers not seeking treatment generally show an attentional bias towards alcohol, whereas problematic drinkers receiving treatment have been shown to overtly avoid alcohol-related cues (Field, Marhe, & Franken, 2014).

The interpretation bias is often measured with the implicit association task (IAT; Greenwald, McGhee, & Schwartz, 1998) and word association tasks. Using the IAT, individual differences in associations between alcohol and other targets (e.g., positive vs. negative; arousal vs. sedation) can be studied by asking participants to categorise words or pictures as quickly as possible (see for example Houben & Wiers, 2006; De Houwer, Crombez, Koster, & De Beul, 2004; Wiers, Van Woerden, Smulders, & De Jong, 2002). Using this task, it was found that light and problematic drinkers showed both alcohol-negative as well as alcohol-positive associations (De Houwer et al., 2004; Wiers et al., 2006). In addition, problematic drinkers also showed associations between alcohol and arousal, whereas light drinkers did not (Houben & Wiers, 2006; Wiers et al., 2002). In word association tasks, participants are asked to generate their first, spontaneous response when hearing an ambiguous, alcohol-relevant word, sentence or scenario (such as "draft", "pitcher" or "Friday night – out with friends"). Studies examining the interpretation bias with word association tasks have consistently shown that problematic drinkers interpret these cues more often in an alcohol-related way than light drinkers, which is indicative of an interpretation bias (Ames, Sussman, Dent, & Stacy, 2005; Krank, Schoenfeld, & Frigon, 2010; Salemink & Wiers, 2014; Woud, Fitzgerald, Wiers, Rinck, & Becker, 2012; Woud et al., 2014).

Executive control

In addition to stronger implicit processes, chronic and/or excessive SU also relates to weaker explicit processes. More specifically, chronic and/or excessive SU leads to a disrupted inhibitory control system, as reflected in executive dysfunctioning (Koob, 2013). Similarly, executive dysfunctioning has been identified as a potential risk factor for developing SUD (Verdejo-García, Lawrence, & Clark, 2008). Executive control has been studied using self-report measures, questionnaires or observations made by informants and neurocognitive test batteries. Computerised assessments of executive control have become especially popular during the past decade (Josman, Klinger, & Kizony, 2008) and several paper-and-pencil tests have been computerised to increase their practical utility. Working memory capacity, for example, can be studied using computerised versions of the Corsi block tapping task (Corsi, 1972) and Self-ordered pointing task (Petrides & Milner, 1982), while the Go/No-go task (Newman & Kosson, 1986) and the Stop signal task (Logan, Cowan, & Davis, 1984) are both useful to study inhibitory control.

Using these computerised neurocognitive tests, research has repeatedly shown cognitive and executive deficits in problematic drinkers. In his review, Parsons (1998) states that the most common deficits seen in problematic drinkers are those related to

memory, learning, problem-solving, processing speed and cognitive efficiency. When focussing specifically on executive deficits, problematic drinkers often show a smaller working memory capacity (Bechara & Martin, 2004; Grenard et al., 2008) and less behavioural control (Kamarajan et al., 2005; Li, Luo, Yan, Bergquist, & Sinha, 2009) and show more difficulty in delaying gratification (for a review, see MacKillop et al., 2011) compared to light drinkers. The severity of these cognitive and executive deficits seems to increase with more severe levels of alcohol-related problems in some studies (Cunha & Novaes, 2004). It should be noted that the results of previous research have been mixed and executive dysfunctioning in problematic drinkers has not uniformly been found (e.g., Ellingson, Flemming, Verges, Barthowos, & Sher, 2014; Fernie, Cole, Goudie, & Field, 2010; MacKillop, Mattson, MacKillop, Castelda, & Donovick, 2007). This suggests that cognitive and executive deficits vary across participants and represent a diffuse pattern of neuropsychological alterations in the brain (Parsons, 1998).

Potential practical implications

In addition to providing a theoretical framework to explain the development and maintenance of SUD, studying the neuropsychological underpinnings of SUD also has important practical implications for the screening, assessment and treatment of SUD (Stacy & Wiers, 2010; Yücel & Lubman, 2007). First, measures of cognitive biases are thought to be useful in the screening, assessment and treatment of SUD. For example, as cognitive biases appear to reduce as a consequence of treatment, the strength of the biases at the start of treatment may serve as a predictor of treatment outcome while the reduction in strength at post-treatment may have utility as an assessment tool for treatment outcome. Recent research also suggests that directly influencing the strength of the cognitive biases in so-called cognitive bias modification procedures may provide an additional aspect of SUD treatment. Second, the diagnostic and treatment process could also target the motivation and ability to control the implicit processes, for example by training executive control. As these measures do not rely on verbal capacity, are less susceptible to social desirability and are generally easy to complete, they might be especially useful in the care for individuals with MBID and SUD.

The present thesis

In sum, SU(D) is highly prevalent among individuals with MBID. Yet, tools for screening, assessing and treating SUD in this population are scarce. Measuring the deficiencies in information processing related to chronic and/or excessive SU (i.e., cognitive biases and executive dysfunction) seems particularly useful for this purpose. However, although these neuropsychological consequences of SUD have been studied extensively over the past years, this research has not yet generalised to individuals with MBID. It is unsure if

the same deficiencies in information processing can be detected in individuals with MBID, how these deficiencies manifest themselves and if and how these deficiencies differ from those without MBID.

The overall aim of the present thesis was to study the deficiencies in information processing associated with SUD (i.e., cognitive biases and executive dysfunctioning) in problematic drinkers with MBID. The objectives were to 1) develop and test indirect measures of cognitive biases and executive dysfunction for problematic drinkers with MBID, and 2) study the extent and nature of the influence of IQ and executive control on these deficiencies by comparing individuals with and without MBID. The results would provide practical implications for the usefulness of these measures in daily practice that could be directly translated into the day-to-day care of problematic drinkers with MBID, including the screening, assessment and treatment of SUD.

To meet the aims and objectives, several studies were conducted. The characteristics of the studies included in this thesis are summarised in Table 1. *Chapter 2* is an introductory chapter in which an overview of the current knowledge on prevalence and risk factors, screening and assessment and treatment of SUD in individuals with MBID is provided. Following the dual process models of addiction, the remainder of this thesis consists of two parts. *Part I* consists of four studies focussing on the automatic processing of stimuli and the existence of cognitive biases in attention, evaluation and approach tendencies in problematic drinkers with MBID. The *Intermezzo* describes two studies on the interpretation bias, or the tendency for problematic drinkers to interpret ambiguous, alcohol-relevant words, phrases and scenarios in an alcohol-related way. Although participants are asked about automatic associations and interpretations, they can assert control over their responses. The interpretation bias therefore contains both automatic and controlled processing and is described separately. *Part II* consists of four studies focussing on the controlled processing of stimuli and – more specifically – the executive and cognitive functioning of problematic drinkers with MBID. The final chapter, *Chapter 13*, provides a summary of the main findings of this thesis and presents its general conclusions. The chapter ends with the practical implications of the results and the usefulness of implicit measures for the screening, assessment and treatment of SUD in individuals with MBID.

Table 1 Characteristics of the studies included in this thesis.

Chapter	Dataset	Sample	Age range	Setting(s)	Design	Main method(s)
3	1	40 long-term abstinent light and problematic drinkers with and without MBID	22–59 years	Forensic psychiatric centre	Cross-sectional	Pilot study; survey
4	2	57 long-term abstinent light and problematic drinkers with and without MBID	22–62 years	Forensic psychiatric centre	Cross-sectional	Pilot study; implicit measures
5	3	130 current light and problematic drinkers with and without MBID	18–61 years	ID care; addiction medicine; control	Cross-sectional	Implicit measures
6	4	133 current light and problematic drinkers with and without MBID	18–65 years	ID care; addiction medicine; control	Cross-sectional	Implicit measures
7	4, 7	230 current light and problematic drinkers with and without MBID	18–61 years	ID care; addiction medicine; control	Cross-sectional	Implicit measures
8	5	178 current light and problematic drinkers with and without MBID	18–68 years	ID care; addiction medicine; control	Cross-sectional	Implicit measures; survey
9	6	40 long-term abstinent light and problematic drinkers with and without MBID	21–63 years	ID care; addiction medicine; control	Cross-sectional	Pilot study; executive control tasks
10	7	112 current light and problematic drinkers with and without MBID	18–60 years	ID care; addiction medicine; control	Cross-sectional	Implicit measures; executive control tasks
11	8	117 participants with MBID	20–68 years	Forensic psychiatric centre ; ID care	Cross-sectional	IQ test
12	3, 4, 5, 7	474 light and problematic drinkers with MBID	18–68 years	ID care; addiction medicine; control	Cross-sectional	IQ test

Note. MBID = mild to borderline intellectual disability.

2

Substance use disorders in individuals with mild to borderline intellectual disability

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Abstract

Knowledge regarding substance use (SU) and substance use disorder (SUD) in individuals with mild to borderline intellectual disabilities (ID) has increased over the last decade, but is still limited. Data on prevalence and risk factors are fragmented and instruments for screening and assessment and effective treatment interventions are scarce. Also, scientific developments in other fields are insufficiently incorporated in the care for individuals with ID and SUD. In this selective and critical review, we provide an overview of the current status of SU(D) in ID and explore insights on the conceptualisation of SUD from other fields such as addiction medicine and general psychiatry. SU(D) turns out to be a chronic, multifaceted brain disease that is intertwined with other physical, psychiatric and social problems. These insights have implications for practices, policies and future research with regard to the prevalence, screening, assessment and treatment of SUD. We will therefore conclude with recommendations for future research and policy and practice, which may provide a step forward in the care for individuals with ID and SUD.

Introduction

Although substance use (SU) and substance use disorders (SUD) among individuals with mild to borderline intellectual disability (ID; IQ 50–85, American Psychiatric Association [APA], 2013) have gained attention over the past decade, there are still many gaps in our knowledge on prevalence and risk factors (Carroll Chapman & Wu, 2012) and there is a dearth of tools for assessment and effective treatment interventions (Kerr, Lawrence, Darbyshire, Middleton, & Fitzsimmons, 2013). In addition, practitioners and researchers working with this target group insufficiently incorporate scientific developments in other fields, including addiction medicine and general psychiatry, into the care of and research on SU(D) in ID. For example, while in ID services SUD is commonly viewed as a relatively simple behavioural problem (Simpson, 2012), in addiction medicine SUD is generally seen as a chronic brain disease (Hyman, 2005), which is characterised by the persistent desire to use and the inability to cut down or control SU, even in the face of negative consequences (APA, 2013)[1]. These insights should have consequences for the care and treatment of individuals with ID with SUD and the field of research on SU(D) in ID (Van Duijvenbode, Didden, Voogd, Korzilius, & Engels, 2012b). In this selective and critical review, we will first describe the current status and challenges regarding SU(D) in ID. We will then explore insights on the conceptualisation of SUD from general psychiatry and addiction medicine. Last, we will describe implications these conceptualisations have for the care and treatment of individuals with ID and SUD as well as future research in this area.

Current status

There is a growing body of research on SU(D) among individuals with ID, who have been identified as a risk group for more severe negative consequences of SU (Slayter, 2008) and for developing SUD (Burgard, Donohue, Azrin, & Teichner, 2000; McGillicuddy, 2006). In this section, we will describe the literature on the prevalence and risk factors, screening and assessment and treatment of SUD in ID and the gaps in our current knowledge on these topics.

Prevalence and risk factors of substance use disorders

Although large population-based studies into SU(D) among individuals with ID are lacking, data suggest that all types of substances are used in this group (To, Neirynck, Vanderplasschen, Vanheule, & Vandevelde, 2014; VanDerNagel, Kiewik, Buitelaar, & De Jong, 2011a). While alcohol is the main substance used and misused in both individuals with and without ID, percentages of alcohol use and misuse seem to be lower among those with ID and a large proportion of individuals with ID are teetotallers (i.e., they do not use any substances; Simpson, 2012; VanDerNagel et al., 2011a). In a Dutch survey, the

prevalence of the use and misuse of cannabis and other illicit drugs among individuals with ID, on the other hand, seemed relatively high compared to that in individuals without ID (VanDerNagel et al., 2011a).

Based on previous studies, the total prevalence of SUD was estimated by Sturmey, Reye, Lee and Robek (2003) around 0.5–2% of the ID population. In an American study using Medicaid files, Slayter (2010) found that 2.6% (n = 9484) of the clients with a diagnostic code for ID also had a code for SU related treatment. A capture-recapture analysis, however, showed that the reported 4.0% SUD in an ID facility and 5.2% ID in an addiction medicine service in the same region in The Netherlands had limited overlap. Single source data thus underestimate the population prevalence of co-occurring SUD and ID (VanDerNagel et al., 2014). The prevalence of SU(D) in ID also highly depends on sample characteristics (Carroll Chapman & Wu, 2012). For instance, in a British community-based study among 1023 adults with mild to profound ID, Cooper, Smiley, Morrison, Williamson and Allen (2007) found 1% of SUD diagnosis, while McGillicuddy and Blane (1999) found 21% alcohol misusers in a community sample (n = 122) with mild to moderate ID in the US. In referred samples (see e.g., Chaplin, Gilvarry, & Tsakanikos, 2011; Didden, Embregts, Van der Toorn, & Laarhoven, 2009) or forensic samples (see e.g., Hassiotis et al., 2011; Lindsay et al., 2013) even higher percentages of substance misusers are found. Although risk factors for SUD for individuals with ID have not been identified yet, these studies suggest that those with mild or borderline ID, psychiatric co-morbidity and forensic or severe behavioural problems are especially at risk for developing SUD.

The epidemiological findings illustrate some of the challenges associated with establishing prevalence rates of SU(D) in ID, including (1) definition of ID-group (in- or excluding the high risk group with borderline ID; IQ 70–85); (2) differences between specific subgroups (such as those receiving ID service or SUD treatment, those with co-morbid psychiatric disorders or forensic patients); (3) definitions of terms such as substance use and misuse, as well as the scope of SU (in- or excluding use of tobacco and/or prescribed drugs); (4) methodological and measurement issues (use of proxy or self-report); (5) problems associated with stigma and denial of substance related problems (both by individuals with ID and their caregivers); (6) variations in prevalence rates over time; and (7) differences between countries, cultures and regions (differences in socio-economical factors, ID service and addiction treatment facilities and alcohol and drugs related policies and legislation; Carroll Chapman & Wu, 2012). Thus, representative and large scale studies on SU(D) in ID are hindered by practical and methodological challenges. Those identified with SUD are probably the 'tip of the iceberg' and may not be representative for the total population (VanDerNagel et al., 2011a).

Screening and assessment of substance use disorders

Parallel to the lack of data on population prevalence of SU(D) in ID, co-occurring SU(D) and ID often remains unrecognised in individual clients (VanDerNagel et al., 2011a). In

many if not most ID services, there is a lack of screening and formal assessment of SU(D) and staff members mostly rely on their clinical judgement to tap SU(D), even while they indicate that they lack the skills and knowledge to do so (McLaughlin, Taggart, Quinn, & Milligan, 2007; VanDerNagel et al., 2011a). Unfortunately such judgements are proven to be unreliable (Connors & Maisto, 2003; Wilson, Sherritt, Gates, & Knight, 2004). For example, proxy reports such as those of staff members typically underestimate clients' SU (Wilson et al., 2004). Also, because of the lack of systematic screening, staff members' attention is predominantly drawn to the more severe cases, disregarding the less progressed cases and thereby missing opportunities to intervene at an early stage (VanDerNagel et al., 2011a).

Systematic screening for SU(D) in the ID population is further hindered by the fact that suitable instruments are lacking. Widely used screening instruments for SU(D) such as the CAGE (Mayfield, McLeod, & Hall, 1974), MAST (Selzer, 1971) and AUDIT/DUDIT (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Berman, Bergman, Palmsteirna, & Schlyter, 2003) are unfit for this population because of (1) the requirement of (substance-related) knowledge that individuals with ID often lack, (2) the use of lengthy phrases, difficult wordings or (double) negative phrases, and (3) the tendency of individuals with ID to acquiescence (i.e., to agree with whatever statement has been given) as well as to "say nay" regarding questions relating to social taboos such as SU (Finlay & Lyons, 2001; Heal & Sigelman, 1995; McGillicuddy, 2006; Sturmey et al., 2003; VanDerNagel, Kiewik, Van Dijk, De Jong, & Didden, 2011b). Hence, because a number of reasons, ID services often fail to recognise co-occurring SU(D) and ID.

Treatment of substance use disorders

Although interventions for SUD in individuals with ID have been developed in the past decade, little has been published on their effectiveness (Kerr et al., 2013; McGillicuddy, 2006). Kerr et al. (2013) identified nine tobacco and alcohol-related interventions for individuals with mild to moderate ID. Several conclusions may be drawn from their review. First, their findings suggest that – with minor adaptations in the communication – interventions based on motivational interviewing techniques can be applied and seem to be effective in increasing the motivation of individuals with ID to enter into and adhere to treatment (see also Frielink & Embregts, 2013). Second, there is some evidence that educating clients with ID about the adverse effects and risks of SU improves their substance-related knowledge. These interventions typically consist of several weekly group sessions, in which clients are provided with information about tobacco smoking and alcohol drinking (e.g., motives for drinking or smoking, the law, short and long term effects and adverse consequences of smoking and drinking) and which aim to reduce SU and to prevent the development of SUD. It should be noted, however, that these interventions not always lead to a reduction in SU (e.g., Kelman, Lindsay, McPherson, & Mathewson, 1997; Lindsay, McPherson, Kelman, & Mathewson, 1998). Third, a number of

interventions developed for individuals with ID aim for behavioural change, such as cutting down or quitting SU, and improving skills related to this behavioural change such as social skills, coping skills and refusal skills. These interventions seemed effective in eliciting behavioural change and reducing SU.

Several problems can be identified when examining both the design and methodology of the studies as well as the interventions themselves. First, the studies were of poor to moderate methodological quality, often used small participant numbers (range 1–138, median 7) and in most cases failed to include a control or comparison group. Kerr et al. (2013) therefore conclude that the body of evidence on the feasibility, appropriateness, meaningfulness and effectiveness of SU(D) interventions for individuals with ID is small. Second, the interventions were often short (3–12 sessions, median 7), relatively simple of nature and lacked a theoretical foundation. Also, all these interventions seemed to focus on SU, rather than SUD, and disregarded possible co-morbid disorders or psychosocial problems. The evidence for the effectiveness of these interventions thus remains at the level of pilot tests.

Insights from other fields

In ID services, SU(D) is often seen as a behavioural problem that can be amended in relatively brief and targeted behavioural and/or educational interventions. In this section, we will discuss insights on the conceptualisation of SUD from other fields, such as general psychiatry and addiction medicine. The implications these insights have on the care and treatment of individuals with ID and SUD will be discussed later in this chapter.

Substance use disorder is a multifaceted problem

In addiction medicine, SUD is conceptualised as a multifaceted problem that cannot be explained by a single factor and is often associated with co-morbid physical and psychiatric disorders and other psychosocial problems. This is reflected in the biopsycho-social model, which emphasises the complex interplay between biological (e.g., genetics, physiological effects of substances), psychological (e.g., personality traits, co-morbid psychiatric disorders) and social factors (e.g., social economical status, peer pressure) (Donovan, 2005). For example, while SU is to a high degree dependent on social conventions (e.g., toasting with a glass of wine, taking a cigarette-break), biological and psychological factors such as genetics and personality traits contribute to inter-individual differences in vulnerability for developing SUD (Conrod, Pihl, Stewart, & Dongier, 2000; Merikangas & McClair, 2012; Wong & Schumann, 2008). All factors – biological, psychological and social – interact with each other and can increase or decrease the risk for developing SUD in a given individual.

The multifaceted nature of SUD is also reflected in the high co-morbidity between SUD and physical and psychiatric problems (Kessler, 2004; Mertens, Lu, Parthasarathy, Moore, & Weisner, 2003; O'Brien et al., 2004). For example, epidemiological studies estimated that between 20 and 50% of clients receiving mental health treatment have had a lifetime diagnosis of SUD and over half of the clients in addiction medicine have had a co-morbid psychiatric disorder in their lifetime (Center for Substance Abuse Treatment, 2007). The co-morbidity of SUD and physical and psychiatric disorders leads to further complications: co-morbidity increases symptom severity of both disorders, complicates treatment and causes additional psychosocial problems including failure at work or school, delinquency, financial problems and homelessness (Horsfall, Cleary, Hunt, & Walter, 2009; Sterling, Chi, & Hinman, 2011). As opposed to a relatively simple behavioural problem, SUD is therefore best conceptualised as a complex and multifaceted disorder that is caused by multiple factors and is associated with co-morbid problems.

Substance use disorder is a brain disease

In the 90s, it became clear that SUD is characterised by disruptions in brain regions important to the motivational, reward and inhibitory control processes (Koob, 2013; Volkow, Wang, Tomasi, & Baler, 2013). These neural adaptations are reflected in dual process models, which state that behaviour is influenced by both implicit, automatic processes (e.g., attention, evaluation of environmental cues and approach/avoidance behaviour) and explicit, controlled processes (such as executive control and motivation) (e.g., Bechara, Noel, & Crone, 2006; Gerard, Gibbons, Houlihan, Stock, & Promery, 2008; Wiers et al., 2007). Both these types of processes are implicated in SUD.

The implicit processes are associated with the limbic system of the brain (Nestler, 2005) which becomes hypersensitive to the rewarding effects of substances (Robinson & Berridge, 2003, 2008). More specifically, the rewarding effects of substances and related stimuli (e.g., external stimuli such as persons, places and drug paraphernalia, but also interceptive stimuli including emotions, stress and craving) become overvalued at the expense of other rewards (Hyman, Malenka, & Nestler, 2006; Nestler, 2005). As a result, these stimuli seem attractive, 'grab attention' and elicit approach behaviour (Robinson & Berridge, 2003, 2008). Indeed, research has shown that SUD is associated with biases in cognitive processing, including biases in attention, evaluation and approach tendencies. SUD also leads to changes in the explicit processes, which are associated with the frontal cortex. As a result of reduced baseline activity in regions of the frontal cortex (hypofrontality; Dackis & O'Brien, 2005; Hyman et al., 2006) clients with SUD show poorer executive functioning and consequently have impaired top-down control over behaviour. Both the effects of SUD on the implicit processes as well as on the explicit processes have been shown for a wide range of substances including tobacco, alcohol, cannabis and cocaine (for a review, see Field & Cox, 2008; Verdejo-García, Lawrence, & Clark, 2008). This demonstrates that, even though each class of drugs has its own pharmacological

mechanisms, they share several functional changes in the nervous system when used repeatedly.

The dual process models thus theorise that SUD is not merely a behavioural problem, the result of faulty decision making or even the result of a lack of willpower, but in part reflects structural neural adaptations that often exert their influence outside conscious control.

Substance use disorder is chronic

Rather than resulting from a personal choice (or flaw for that matter), SUD is seen as a chronic disorder, similar to other chronic medical illnesses such as diabetes mellitus, hypertension and asthma (McLellan, Lewis, O'Brien, & Kleber, 2000). Evidence for this comes from three different research areas (Dennis & Scott, 2007): epidemiology, clinical treatment and biological studies. First, results of epidemiological studies show that SUD most often develops during adolescence (14–16 years) and lasts for several decades (Swendsen et al., 2012). Second, there is a large body of clinical research indicating that 40–60% of alcohol or drug misusers relapse – even after prolonged periods of abstinence – and require multiple treatment episodes spanning several years to recover from SUD (Bailey, Herman, & Stein, 2013; Dennis, Foss, & Scott, 2007; National Institute on Drug Abuse, 2012). Also, treatment adherence and relapse rates of SUD treatment are quite similar to those of other chronic medical illnesses (McLellan et al., 2000). Third, there is evidence for a biological basis underlying the chronicity of SUD, demonstrating that SUD is associated with several changes in the brain that impact decision making, emotional states and behaviour (see earlier in this chapter). These substance-induced alterations of the brain often persist way beyond cessation, resulting in a continued vulnerability for relapse (Johanson et al., 2005; Petry, 2001). However, they do seem to diminish after prolonged periods of abstinence (for a review see Garavan, Brennan, Hester, & Whelan, 2013), providing arguments for the need for long-term rehabilitation and care.

Future directions

Based on the current status on SU(D) in ID and the insights of SUD described in the previous section, we can conclude that considering SUD in ID as a behavioural problem does no justice to the complex and chronic nature of SUD and leads to a simplified view on how individuals with ID and SUD should be cared for or treated. In this section, we propose several lines of research (see Table 1 for a brief overview) to accommodate a conceptual change of SUD as a result of which the understanding and care of SUD in individuals with ID are enhanced.

Prevalence and risk factors of substance use disorders

The inter-individual variability in vulnerability to developing SUD not only calls for more knowledge on prevalence and risk factors of SU in the total population of individuals with ID (Carroll Chapman & Wu, 2012; McGillicuddy, 2006), but also across specific high-risk groups within this population.

With regard to the population prevalence of SU(D) among individuals with ID, research in larger samples of individuals with ID is needed to plan treatment capacity and develop strategies for prevention and early detection (Carroll Chapman & Wu, 2012; VanDerNagel et al., 2014). This research should include a variety of research methods, such as biomedical markers of SU, administrative data and multicentre studies (e.g., Connors & Maisto, 2003; Slayter, 2010; VanDerNagel et al., 2014). Also, this research should take into account the challenges described earlier. For example, definitions of both ID (in- or excluding individuals with borderline ID) and SU (in- or excluding tobacco use) influence the prevalence of SU(D) and should therefore be justified in the study design.

Prevalence studies are also helpful in identifying groups at risk, which in turn contributes to the targeted prevention of SU(D) (McGillicuddy, 2006). Based on the current literature, individuals with mild to borderline ID, individuals with co-morbid psychiatric disorders and individuals in forensic facilities seem to be at increased risk for developing SUD. Future studies should further explore risk factors for SUD, including motives for SU, client characteristics (e.g., personality traits, coping skills, executive functioning including working memory, behavioural inhibition, delay discounting) and social factors (e.g., living arrangements, employment, social environment, peer pressure). Primary and secondary prevention strategies can then target these risk factors and their effectiveness can be explored in studies with larger samples and internally valid designs.

Considering the chronic nature of SUD, there is a need for studies into the age at which individuals with ID commonly start to use substances, the development of SUD after initial SU and rates of relapse after cessation. This research identifies risk factors associated with the development of SUD and long-term consequences of SUD (Carroll Chapman & Wu, 2012) and could point out similarities and differences between individuals with ID and their non-disabled peers, for example in the risk of developing SUD after initial SU and the consequences of SU(D) – which are thought to differ between the two groups (e.g., Burgard et al., 2000; McGillicuddy, 2006; Slayter, 2008). Last, as Didden et al. (2009) suggest, associations between SUD and co-morbid physical or psychiatric disorders and other psychosocial problems may also provide a new line of inquiry which leads to a better understanding of the development of SUD in individuals with ID and the implications co-morbidity has on the care for individuals with ID.

Screening and assessment of substance use disorders

Screening and assessment of SU(D) are essential, especially in high risk groups such as those with mild to borderline ID. To aid early detection, there are four lines of inquiry and

Table 1 Brief overview of the current status of substance use disorder (SUD) in individuals with intellectual disability (ID), directions for future research in this area and recommendations for policy and practice.

Topic	Current Status
Prevalence and risk factors	· Individuals with ID are at risk for developing SUD and experience more severe consequences of SU(D). · The prevalence of SUD highly depends on sample characteristics. · There are certain high-risk groups (e.g., individuals with mild to borderline ID, those with co-occurring psychiatric disorders or forensic patients). · Research in this area is plagued with several challenges, including practical and methodological issues.
Screening and assessment	· SU(D) often remains unrecognised, partly due to a lack of screening and formal assessment. · SU is often assessed using collateral reports such as those of staff members.
Treatment	· There is a small number of published SUD treatment interventions for individuals with ID. · The interventions are often short and relatively simple in nature, focussing solely on SUD. · The body of evidence on the effectiveness of the interventions is very small.

areas of concern to policy and practice. First, it is advised that SU becomes a common subject of conversation with clients and is removed of possible stigma. Second, staff members need to be educated about the underlying mechanisms of SUD and contemporary views on SUD and trained to increase their skills in recognising the signs of SU(D), addressing SU with their clients and motivating them to enter into and adhere to treatment in the case of SUD (see also Moore & Lorber, 2004). Third, it is advised that service providers systematically screen for SU(D). This should not be limited to clients at risk for developing SUD or clients suspected of SU, but instead be implemented in the

Directions for future research	Recommendations for policy and practice
· Establish the prevalence of SUD among individuals with ID in general and across specific high-risk groups within this group. · Include a variety of research methods. · Explore risk- and protective factors for SUD, including client characteristics, and develop prevention strategies aimed at these risk factors. · Study the course of SUD in individuals with ID.	· Be aware that SU(D) is common and that all types of substances are used by individuals with ID. · Pay attention to high-risk groups (such as individuals with mild to borderline ID, those with co-occurring psychiatric disorders or forensic patients).
· Develop screening and assessment instruments of SU(D) and co-occurring problems targeted to needs of those with ID.	· Remove SU of stigma by making it a common subject of conversation. · Educate staff members in SUD and increase their skills in recognising, screening and assessing SU(D). · Implement SU(D) screening in routine diagnostic procedure. · Extend SUD assessment with assessment of co-occurring problems
· Develop interventions: · of less to more intensity and duration; · targeted at the biological, psychological and social aspects of SUD; · taking into account co-occurring problems; · tailored to the needs of individuals with ID. · Investigate the applicability and effectiveness of existing evidence-based pharmacological and psychosocial interventions in individuals with ID. · Identify barriers to treatment access and propose ways to aid referral. · Identify ways to promote collaboration and cross-fertilisation between sectors of the health care system.	· Include biological and psychological and social interventions in the treatment arsenal. · Implement stepped care; match the intensity of the intervention to the severity of SUD. · Structure SUD treatment according to the chronic care approach; also focus on long-term management. · Tailor all interventions to the needs of individuals with ID. · Collaborate with other sectors of the health care system to provide integrated treatment. · Educate others about your area of expertise to promote collaboration.

routine diagnostic procedure applied to all clients with mild to borderline ID. Fourth, research should be directed at developing and implementing screening instruments of both SU(D) and physical, psychiatric and psychosocial co-morbidity that are tailored to the needs of individuals with ID. These instruments should then be implemented in the routine diagnostic process. Below are two examples of such research currently being undertaken.

First, the Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q; VanDerNagel et al., 2011b), a Dutch language instrument, has been developed to assess

SU, risk factors of SUD and SU consequences in individuals with mild to borderline ID. It takes into account challenges individuals in this group have with lengthy or complex phrases and difficult wording, substance-related jargon and knowledge and tendencies to acquiescence or 'say nay' (VanDerNagel, Kemna, & Didden, 2013). In the SumID-Q, SU is discussed in an empathetic, non-confrontational way. The first part of the SumID-Q interview assesses the client's familiarity with substances (e.g., alcohol, cannabis), presenting substance-related pictures and asking what is shown. This will clarify the terminology of the client, which is then used in the remainder of the interview to prevent misunderstandings and to make the client feel at ease. In the second part of the interview clients are asked about their knowledge of and attitude towards using these substances, as well as SU by close others (i.e., friends, family, staff members). Discussing these topics without (negative) judgement facilitates the client to speak freely and truthfully when asked about his own SU. Patterns of SU are further explored by asking about frequencies and quantities of SU and circumstances in which substances are regularly used. Preliminary data show promising validity and feasibility (VanDerNagel & De Jong, 2012). We are currently validating the SumID-Q, examining its feasibility, reliability and validity in subgroups of individuals with ID (e.g., adolescents, forensic clients) and implementing the SumID-Q in ID facilities, mental health care settings and centres for addiction medicine and general psychiatry.

Second, studies into substance-induced brain alterations (e.g., cognitive biases and deficiencies in executive functioning) are needed to better understand the role of cognitive performance in the development and maintenance of SUD and similarities and differences between individuals with ID and their non-disabled peers. For example, deficiencies in executive functioning among individuals with ID could provide a partial explanation for their heightened risk for developing SUD, as these deficiencies have been identified as vulnerability markers (Van Duijvenbode, Didden, Korzilius, Trentelman, & Engels, 2013). Implicit measures of cognitive biases and executive functioning could also be used as screening or assessment instruments for SUD, they may predict treatment outcome or be incorporated in SUD treatment (Stacy & Wiers, 2010). As these measures do not rely on verbal capacity of clients, are generally easy to conduct and are less susceptible to social desirability, they might be especially useful in the care for individuals with ID and SUD. Preliminary results indicate not only that computerised tasks to measure cognitive biases – such as the visual dot probe task (MacLeod, Mathews, & Tata, 1986) and the approach avoidance task (Rinck & Becker, 2007) – are applicable in individuals with ID but also that IQ does not appear to be associated with the strength of these biases (Van Duijvenbode et al. 2012b). In line with other research (e.g., Garavan et al., 2013), the results also suggest that substance-induced deficits in information processing and executive functioning diminish over time and are no longer present in long-term abstinent alcoholics, both with and without ID (Van Duijvenbode, Didden, Bloemsaat, & Engels, 2012a; Van Duijvenbode et al., 2012b; Van Duijvenbode et al., 2013). However, these results

are preliminary and there is a need to replicate these studies. We are currently conducting studies aimed at replicating and expanding these findings in current substance users with ID, examining the role of IQ and executive functions more closely, identifying the most appropriate measures and parameters and implementing the measures into the process of screening, assessment and treatment of SUD in individuals with ID in clinical practice.

Treatment of substance use disorders

The nature of SUD as a multifaceted problem calls for the development of treatment approaches that take multiple (risk) factors into account (Shapiro, Coffa, & McCance-Katz, 2013). The biopsychosocial approach of SU(D) provides a framework for developing such treatment models. From this model it follows that research should be directed at developing a variety of interventions, both biological, psychological and social (Reif et al., 2014). A first line of inquiry should therefore be to adopt existing evidence-based psychosocial treatment interventions (such as cognitive behavioural therapy, community reinforcement approach and motivational interviewing) to the needs of those with ID (for suggestions see Degenhardt, 2000; Kerr et al., 2013; McGillicuddy, 2006) and to study their effectiveness. Although steps have been made in doing so, these initiatives often remain at the level of pilot studies and are often not published. Research should therefore also be directed at studying their effectiveness in larger samples and with strong methodological designs. These interventions should also take into account co-morbidity with physical and psychiatric disorders and other psychosocial problems. The development of dual diagnosis (ID plus SUD) or even triple diagnosis (ID plus SUD plus psychiatric disorder) treatment interventions is therefore warranted.

A second line of inquiry is to identify treatment approaches aimed at substance-induced brain alterations of which a procedure called cognitive bias modification (CBM) is an example. Research in individuals without ID has shown that CBM is effective in reducing SU and the risk of relapse (Wiers, Gladwin, Hofman, Salemink, & Ridderinkhof, 2013). Combining CBM with cognitive behavioural strategies in which new skills (e.g., social skills, coping skills and refusal skills) are learned could therefore be an important step towards effective and multifaceted SUD treatment. Another example is the use of pharmacological strategies for treating SUD. A recent review suggests that a series of proven-effective medications are available for non-ID individuals to stabilise SU(D), reduce craving and facilitate abstinence (Van den Brink, 2012). Considering the impairments in brain function associated with individuals with ID (Mental Health Special Interest Research Group, 2001), the applicability, side-effects and effectiveness of CBM and pharmacological strategies in this population remain to be investigated.

As SUD is a chronic disorder, treatment interventions should be structured according to the chronic care approach (McLellan, McKay, Forman, Cacciola, & Kemp, 2005; White, Boyle, & Loveland, 2003). This approach implies the need for a broad spectrum of less to more intensive treatment forms (Dennis & Scott, 2007; McLellan et al., 2005). Related to this

is the implementation of stepped care, where the intensity of the treatment is matched to the severity of SUD (McLellan et al., 2005). Long-term management and monitoring of clients is another crucial aspect of successful treatment. This does not only do justice to the nature of SUD but also allows therapists to quickly respond to any changes in the client's life that may affect treatment success. Research should therefore be directed at developing extended interventions for SUD and successful strategies for maintaining therapeutic contact and client monitoring for a number of years. Research into effective therapeutic and pharmacological relapse prevention strategies, chronic care and harm reduction is also necessary to improve the client's quality of life and minimise societal costs (Collins et al., 2012; Marlatt & Witkiewitz, 2005).

Last, the complex nature of SUD in ID calls for a close collaboration between different sectors of the health care system, including general psychiatry, addiction medicine and ID services (French et al., 2000; Godley, Godley, Dennis, Funk, & Passetti, 2007; Sannibale et al., 2003). This promotes adequate referral to addiction medicine, a smoother transition between the different forms of treatment and health care sectors and has been proven to be effective in improving abstinence rates (e.g., Godley et al., 2007; Sannibale et al., 2003) and reducing long-term societal costs (French et al., 2000). Unfortunately, there are still many barriers to treatment access, especially for individuals with ID. Research suggest that fewer than 25% of the people in need for SUD treatment receive such treatment and this percentage may be even less in individuals with ID (Slayter, 2011). And, if they do, they often are not able to profit from it and are at high risk for drop out (Degenhardt, 2000). Collaboration should therefore be complemented with cross-fertilisation between the different sectors. As McLaughlin et al. (2007) note, professionals in ID services can educate other professionals about the care for individuals with ID, while professionals in addiction medicine can educate others about the nature and treatment of SUD. This could then initiate a joint strategy in providing effective care for clients with ID and SUD.

Conclusion

Although often overlooked in the past, SU(D) in individuals with ID has gained attention over the past decade. In this selective and critical review, we have provided an overview of the current status of SUD in ID, identified gaps in the current literature base and highlighted several issues that need to be addressed in future research. Knowledge on prevalence is scarce and tools for screening, assessing and treating SUD in this population are needed. In ID care, SUD is also often conceptualised as a relatively simple and isolated behavioural problem that can be cured with simple and short interventions. This perspective is not in line with current knowledge of SU(D) in other fields, in which SUD is conceptualised as a complex, chronic brain disease that warrants treatment. Due to the complex nature of SUD, ID services need to work closely together with addiction medicine

and general psychiatry to provide clients with SUD with appropriate assessment, care and treatment. While there are challenges inherent to this, research is needed on a variety of topics, including prevalence and risk factors, screening and assessment and treatment. This research, together with the recommendations we have made in this chapter, could enhance the understanding of SUD in ID and improve the care of individuals with ID and SUD.

Footnotes

[1] According to the APA (2013), SUD encompasses a wide range of disorders from a mild to a severe state of chronically, relapsing and compulsive substance use. Substances are used in larger amounts or over a longer period of time than was intended, despite having knowledge of the adverse physical, psychological, social and interpersonal problems related to SU or even in the face of these consequences. As opposed to SUD, SU does not lead to these adverse consequences or risks.

PART I

Automatic processing

750 ML

ALC. 11,5%

3

Standardisation of pictorial stimuli

This chapter has been published as:
Van Duijvenbode, N., Didden, R., Bloemsaat, G., & Engels, R. C. M. E. (2012). Problematic alcohol use and mild to borderline intellectual disability: Standardization of pictorial stimuli for an alcohol cue reactivity task. *Research in Developmental Disabilities, 33*, 1095–1102.

Abstract

The present study focused on the first step in developing a cue reactivity task for studying cognitive biases in individuals with mild to borderline intellectual disability (ID) and alcohol use-related problems: the standardisation of pictorial stimuli. Participants ($N = 40$), both with and without a history of alcohol use-related problems and varying in IQ, were admitted to a forensic setting and were all abstinent. They were asked to rate familiarity, complexity, valence and attractiveness of pictures portraying both alcoholic and non-alcoholic beverages. There was a tendency to rate non-alcoholic beverages as more pleasant and attractive than alcoholic beverages. In participants with mild to borderline ID, this difference reached statistical significance, even when controlling for alcohol use-related problems in the past. The overall result of the study is a large database of 255 pictures portraying both alcoholic and non-alcoholic beverages that will be used to validate an implicit measure of cognitive biases for alcohol in individuals with mild to borderline ID.

Introduction

In the past few years, it has become clear that alcohol use-related problems pose a major problem in individuals with mild to borderline intellectual disability (ID), defined as having an IQ between 50 and 85 (American Psychiatric Association, 1994; Schalock et al., 2010). Although prevalence rates of alcohol use are lower among these individuals (e.g., Emerson & Turnball, 2005; Robertson et al., 2000), it is generally accepted that their relative risk of alcohol abuse and dependency is higher (Degenhardt, 2000; Didden, Embregts, Van der Toorn, & Laarhoven, 2009). However, there remains variation in the reported prevalence rates of use and abuse of alcohol in individuals with ID (Sturmey, Reyer, Lee, & Robek, 2003). In a review of the literature, Sturmey et al. (2003, p. 44) stated that "it is difficult to define any consensus among the studies as to the prevalence of alcohol misuse among people with learning disabilities, however, prevalence rates may vary somewhere between 0.5% and 2% of this population".

Although the risk factors associated with alcohol use – such as inadequate coping, impaired inhibition and increased amenability – are the same as for individuals without ID, these risk factors are more prevalent in individuals with mild to borderline ID and are often also more severe (McGillicuddy, 2006; Slayter, 2008; Taggart, McLaughlin, Quinn, & Milligan, 2006). In addition, variables associated with mild to borderline ID (such as lack of self-esteem, susceptibility to peer pressure, limited insight into their problems, limited understanding of the consequences of their behaviour and to plan their behaviour accordingly) and often existing co-morbid disorders (Chaplin, Gilvarry, & Tsakanikos, 2011; Taggart, McLaughlin, Quinn, & McFarlane, 2007), increase the risk of problematic alcohol use in this target group.

The consequences of problematic alcohol use are often detrimental. Physical, social and psychological problems related to problematic alcohol use (e.g., health problems, problems with the social network, work- and housing-related problems, aggressive and offending behaviour) are even more prevalent in individuals with mild to borderline ID compared to individuals without ID (Deb & Weston, 2000; Degenhardt, 2000). Despite the potentially adverse consequences, however, individuals with ID often continue the use of alcohol. This persistent desire for alcohol and the inability to cut down or control alcohol use, even in the face of negative consequences, is what makes it so puzzling to others. As Wiers and Stacy (2006, p. 292) note "… the typical problem in addiction is not that drug abusers do not realise that the disadvantages of continued drug use outweigh the advantages. The central paradox in addictive behaviours is that people continue to use substances even though they know the harm".

Dual process models (e.g., Bechara, Noel, & Crone 2006; Gerard, Gibbons, Houlihan, Stock, & Promery, 2008) have been developed that explain this paradox. Their central premise is that there is a distinction between implicit and explicit processes. Implicit processes, such as cognitive biases, are considered to be spontaneous, fast, can sometimes

occur outside of conscious awareness and cannot easily be controlled. Explicit processes, on the other hand, are deliberate and slow and require conscious awareness (Wiers et al., 2007). Both implicit and explicit processes are thought to influence drug seeking behaviour (Wiers et al., 2002). However, due to both the acute effects of alcohol (Fillmore & Vogel-Sprott, 2006) and long-term neuro-adaptations (Bechara et al., 2006) the implicit, automatic tendencies get stronger over time, impairing the ability to inhibit impulsive action tendencies. In addition to this imbalance between explicit and implicit processes, problematic alcohol use also appears to be associated with several cognitive biases, including biases in attention, evaluation and approach tendencies.

Cognitive biases have been the centre of attention in addiction research during the past years and have been studied using various paradigms (Cox, Fadardi, & Pothos, 2006) and stimuli, such as words, pictures and even contemporary movies. Results of a large number of studies in individuals without ID have shown that these biases are reliable and valid indexes of the severity of alcohol use-related problems, in terms of frequency of use (Field, Christiansen, Cole, & Goudie, 2007; Jones, Jones, Smith, & Copely, 2003; Townshend & Duka, 2001). It has therefore been proposed that measuring the strength of cognitive biases – using various alcohol cue reactivity tasks, including the visual dot probe (MacLeod, Mathews, & Tata, 1986) and the approach avoidance task (Rinck & Becker, 2007) – can be used for screening purposes. The measurement of cognitive biases may also have utility as an assessment of treatment success as successful treatment of alcohol use-related problems is thought to reduce the strength of cognitive biases (Cox, Pothos, & Hosier, 2007). This, in turn, is associated with reductions in craving (Field & Eastwood, 2005; Schoenmakers, Wiers, Jones, Bruce, & Jansen, 2007), drinking behaviour (Fadardi & Cox, 2009) and relapse following treatment (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011; Wiers, Rinck, Kordts, Houben, & Strack, 2010).

As Didden et al. (2009) have noted, screening tools and effective therapies for individuals with mild to borderline ID and alcohol use-related problems have not been investigated yet. The fact that alcohol use-related problems and subsequent physical, social and psychological problems are highly prevalent among individuals with ID suggests, however, that research targeting these issues is necessary. Developing and validating a methodology with which cognitive biases can be measured in this target group seems particularly necessary. However, the above research has mainly used healthy subjects as opposed to clinical subjects. As the target group of individuals with mild to borderline ID is known with severe and multiple disorders (Taggart et al., 2007), it is unsure if the same biases can be detected in this target group.

The present study focused on the first step in developing a research tool for studying cognitive biases in problematic alcohol use in individuals with mild to borderline ID, namely standardising pictorial stimuli using stimuli ratings from both drinkers and non-drinkers. In this study, pictures were used to increase ecological validity of the tasks at hand (Mogg, Field, & Bradley, 2005; Traylor, Bordnick, & Carter, 2009). Moreover, by using

pictures the validity is not affected by impaired reading abilities (Adams & Jarrold, 2009) which makes it more suitable for people with ID. Research has identified four parameters important in the standardisation of stimuli: familiarity, complexity, valence and attractiveness of stimuli (Pompéia, Miranda, & Bueno, 2001; Pulido, Brown, Cummins, Paulus, & Tapert, 2010). Familiarity and complexity are considered important predictors of picture naming latency, suggesting that more familiar and less complex pictures are processed faster (Alario & Ferrand, 1999; Miller & Fillmore, 2010). Valence and attractiveness are included as closely tied, but psychologically and neurologically distinguishable, components of reward or incentive salience (Berridge, 1996).

Using these pictorial stimuli, cue reactivity tasks (viz. visual dot probe task, picture rating task and approach avoidance task) will be developed to investigate the presence of cognitive biases in attention, evaluation and approach tendencies and the influence of IQ on these processes. Based on previous research, drinkers are expected to respond differently to pictures of alcoholic beverages compared to non-drinkers. For example, drinkers have been shown to rate alcoholic beverages as more pleasant and more attractive compared to non-drinkers (Bradley, Field, Healy, & Mogg, 2008; Mogg, Bradley, Field, & De Houwer, 2003; Pulido, Mok, Brown, & Tapert, 2009). Individuals with and without ID are not expected to show differences on familiarity, complexity, valence and attractiveness of pictures of both alcoholic and non-alcoholic beverages.

Method

Participants

The present study was conducted at Forensic Psychiatric Centre (FPC) Oldenkotte, one of the twelve forensic psychiatric hospitals in The Netherlands. Participants ($N = 40$; 34 men) were between 22 and 59 years of age ($M = 39.0$, $SD = 8.5$) and were admitted to the clinic with a "disposal to be involuntary admitted to a forensic psychiatric hospital on behalf of the state" (De Ruiter & Hildebrand, 2007, p. 167).

Participants were divided into groups, based on two criteria: intelligence quotient (IQ) and history of alcohol use-related problems prior to admission. IQ was assessed using the most recent scores on the WAIS-III-NL (Uterwijk, 2000b) in the participants' file. For our purposes, only total IQ ($M = 85.4$, $SD = 14.3$, range = 60–112), verbal IQ ($M = 85.2$, $SD = 15.0$, range = 60–119), and performance IQ ($M = 81.2$, $SD = 13.2$, range = 62–104) were used. Sixteen participants were identified as having mild to borderline ID, defined as having an IQ between 50 and 85 (American Psychiatric Association, 1994; Schalock et al., 2010). Of 11 participants, no recent IQ was available due to their recent date of admission. For those participants, only rough estimates of IQ (e.g., mild to borderline ID, below average or average IQ) were available, based on previous IQ tests. Alcohol use-related problems were assessed using DSM-IV-TR criteria and diagnosed by a professional. As all participants

were admitted to a closed treatment facility, they were abstinent from alcohol. Twenty participants were diagnosed with a history of either alcohol abuse (n = 10) or alcohol dependency (n = 10). They had been abstinent for 36.9 months on average (SD = 24.6). Of the participants who had no diagnosis of alcohol use-related problems, five were diagnosed with a history of abuse and/or dependency of other substances, most often cannabis and cocaine. They had been abstinent for 33.2 months on average (SD = 27.9). Nine participants did not have any substance use-related problems in the past.

Based on these two criteria, four groups of participants were formed: (1) participants with mild to borderline ID and a history of alcohol use-related problems (n = 12), (2) participants with an average IQ and a history of alcohol use-related problems (n = 10), (3) participants with mild to borderline ID without a history of alcohol use-related problems (n = 7), and (4) participants with an average IQ without a history of alcohol use-related problems (n = 11). The groups did not differ on gender ratio ($\chi^2(3, N = 40) = .63$, $p = .634$), age ($F(3,39) = 1.07$, $p = .378$) or number of months abstinent ($F(3,39) = 0.77$, $p = .525$).

Stimuli

In the development of the cue reactivity tasks, 269 colour pictures of both alcoholic (N = 140) and non-alcoholic (N = 129) beverages were derived from the internet. The stimuli originated from two different sources. The first picture set consisted of 140 pictures of alcoholic and 129 pictures of non-alcoholic beverages on a white background (see Fig. 1A). All pictures had a similar resolution (96 dpi) and image size (380 x 475 pixels). The second picture set was developed and used previously by Pieters, Burk, Van der Vorst, Wiers and Engels (2012). It consisted of 77 pictures of an individual drinking an alcoholic or non-alcoholic beverage (see Fig. 1B). All pictures were taken from two different angles and included both a male and female version of the person in the picture. The resolution of these pictures was 72 dpi and the image size was 600 x 450 pixels. Eight pictures were deleted due to poor image quality, resulting in a total number of 328 pictures that were shown to participants.

Measures

Participants were asked to rate the familiarity, complexity, valence (liking) and attractiveness (wanting) of the pictures. Familiarity was measured with a three-point Likert-scale, ranging from 1 to 3 (1: *unfamiliar*, i.e., the participant did not recognise the beverage; 2: *questionable*, i.e., the participant did not recognise the beverage or did not know what type of beverage it was; 3: *familiar*, i.e., the participant recognised the beverage and knew what type of beverage it was). Complexity referred to the amount of details in the picture. As in Pulido et al. (2010), participants were asked how difficult it would be for them to describe or draw the picture in detail. Scores ranged from 1 to 3, with 1 for *very simple*, 2 for *not simple, but not complex either* and 3 for *very complex*. Valence (i.e., pleasure/displeasure) was rated on a visual analogue scale of 4 cm, ranging from 2 (*very unpleasant*) to +2 (*very pleasant*).

Figure 1 Sample of pictorial stimuli used. (**A**) Beverages on a white background. (**B**) The pictures derived from Pieters et al. (2012).

Attractiveness (i.e., how much the participant wanted to drink the beverage depicted) was rated on a visual analogue scale of 10 cm, ranging from 0 (*not at all*) to 10 (*very much*).

Procedure

All pictures were randomly divided into four lists of 82 pictures and presented separately and in a fixed order for all participants. Participants rated two parameters using two different picture sets; either familiarity and valence or complexity and attractiveness. Each participant thus rated 164 pictures instead of the total number of 328. Both parameter (familiarity, complexity, valence and attractiveness) and picture set were fully balanced across the four participant groups.

There were no pre-defined inclusion criteria to participate in the study. All patients residing in FPC Oldenkotte could participate, unless the treatment team decided against it (for example because of the current condition of the patient). Of the 110 patients, 90 were approached by the researcher and asked to participate in a 30-min study contributing to research on alcohol. Forty patients agreed to participate in the study. After obtaining their written informed consent, appointments were made. Participants were all tested individually in a quiet room. After entering the room, the researcher explained the procedure. Participants were told they would get to see a large number of pictures portraying alcoholic and non-alcoholic beverages. They were instructed to look

at each picture carefully and to first rate either familiarity or complexity. Next, they were given a different picture set and were instructed to rate either valence or attractiveness. Participants were encouraged to use the entire range of possible responses. After completing the ratings, the researcher gave a debriefing before thanking the participant and ending the session.

Statistical analyses

Information regarding the brightness and colour (red, green and blue) of the pictures were obtained using the GNU Image Manipulation Program (GIMP; Berkeley, CA), an image editing software program. An independent-samples *t*-test was used to compare pictures of alcoholic and non-alcoholic beverages on brightness and colour. Next, mean familiarity scores were calculated across participants. Pictures with a mean score below 2.5 were eliminated from further analysis. An independent samples *t*-test was conducted to compare the familiarity, complexity, valence and attractiveness scores for the remaining pictures of alcoholic and non-alcoholic beverages. Differences in familiarity, complexity, valence and attractiveness ratings between participants with and without a history of alcohol use-related problems and participants with and without a diagnosis of mild to borderline ID were examined using a one-way between-groups analysis of covariance. These results were complemented with a one-way between-group analysis of variance to check for differences in mean scores between the four groups.

Results

Standardisation of the pictures

Of the total 336 pictures, 81 pictures were excluded due to poor image quality or low familiarity ratings, leaving 255 pictures for further analysis. Mean parameter ratings by picture type are shown in Table 1. Pictures of alcoholic and non-alcoholic beverages did not differ significantly on brightness ($t(203) = 1.18$, $p = .237$), colour (blue: $t(203) = 0.62$, $p = .537$; green: $t(203) = 1.55$, $p = .123$; red: $t(203) = 1.73$, $p = .085$) or complexity ($t(203) = 0.04$, $p = .971$). Non-alcoholic beverages were recognised more often than alcoholic ones ($t(203) = 4.04$, $p < .001$), but the magnitude of the differences in mean (mean difference = .12, 95% CI: .06–.18) was very small (eta squared = .007). Non-alcoholic beverages were also rated as more pleasant ($t(203) = 9.98$, $p < .001$) and more attractive ($t(203) = 17.57$, $p < .001$) than alcoholic ones. The magnitude of the differences in the means (mean difference = .88, 95% CI: .71–1.06; mean difference = 3.86, 95% CI: 3.43–4.30 respectively) were large (eta squared = .33; eta squared = .60 respectively).

Table 1 t-Test comparison between alcoholic (N = 88) and non-alcoholic pictures (N = 117) on different parameters.

	Alcohol		Non-alcohol			
	M	*SD*	*M*	*SD*	*t*(203)	*p*
Attractiveness	1.71	1.32	5.57	1.71	17.57	< .001
Complexity	1.50	0.26	1.50	0.28	0.04	.971
Familiarity	2.70	0.23	2.83	0.20	4.04	< .001
Valence	–0.08	0.79	0.81	0.48	9.98	< .001
Brightness	229.88	14.56	232.05	11.65	1.18	.237
Blue	214.74	17.76	213.20	17.47	–0.62	.537
Green	222.25	16.07	218.81	15.45	–1.55	.123
Red	227.46	16.57	223.47	16.10	–1.73	.085

Group differences

One-way between-groups analyses of covariance were conducted to compare differences in familiarity, complexity, valence and attractiveness ratings between participants with and without a history of alcohol use-related problems and participants with and without a diagnosis of mild to borderline ID. Participants' scores on familiarity, complexity, valence and attractiveness of alcoholic beverages or non-alcoholic beverages (depending on the dependent variable) as well as age and sex were used as the covariates. Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression slopes and reliable measurement of the covariate.

After adjusting for ratings of non-alcoholic beverages, sex and age, there were no significant differences between individuals with and without a history of alcohol use-related problems on any of the parameters (Table 2). The two groups did differ significantly on attractiveness of non-alcoholic beverages ($F(1,15) = 6.70$, $p = .021$, $\eta_p^2 = .309$). With the exception of attractiveness of alcoholic beverages ($F(1,15) = 7.27$, $p = .017$, $\eta_p^2 = .327$) there were no significant differences in any of the parameters for either alcoholic or non-alcoholic beverages when comparing participants with and without a diagnosis of mild to borderline ID. This difference remained significant even after controlling for history of alcohol use-related problems ($F(1,14) = 7.79$, $p = .014$, $\eta_p^2 = .358$). These results were complemented with a one-way between-groups analysis of variance to check for differences between the four groups. Participants were divided into four groups: (1) participants with mild to borderline ID and a history of alcohol use-related problems, (2) participants with an average IQ and a history of alcohol use-related problems, (3) participants with mild to borderline ID without a history of alcohol use-related problems, and (4) participants with an average IQ without a history of alcohol use-related problems.

Table 2 Descriptives and ANCOVA results by picture type (alcohol and non-alcohol) per participant group (participants with and without a history of alcohol use-related problems and with and without mild to borderline intellectual disability).

	Alcohol use-related problems						**Intellectual disability**					
	Yes		No		ANCOVA		Yes		No		ANCOVA	
	M	*SD*	*M*	*SD*	*F*(1,15)	*p*	*M*	*SD*	*M*	*SD*	*F*(1,15)	*p*
Attractiveness												
Alcohol	1.78	2.01	2.14	2.45	0.09	.766	0.74	0.84	3.15	2.45	7.27	.017
Non-alcohol	4.52	1.98	6.54	1.85	6.70	.021	5.66	2.48	5.21	1.83	0.09	.763
Complexity												
Alcohol	1.63	0.38	1.83	0.55	1.79	.201	1.88	0.49	1.59	0.42	0.75	.401
Non-alcohol	1.66	0.48	1.72	0.58	1.02	.329	1.93	0.59	1.48	0.36	2.37	.144
Familiarity												
Alcohol	2.48	0.39	2.46	0.47	0.04	.849	2.44	0.39	2.50	0.46	0.62	.445
Non-alcohol	2.75	0.30	2.78	0.20	0.14	.719	2.81	0.15	2.71	0.33	1.29	.273
Valence												
Alcohol	0.24	1.01	-0.36	0.93	3.42	.084	0.14	1.28	-0.17	0.73	0.49	.496
Non-alcohol	0.78	0.52	0.80	0.83	0.32	.578	0.70	0.80	0.86	0.53	0.10	.759

Note. ANCOVA = Analysis of Covariance.

There was a statistically significant difference at the $p < .05$ level in attractiveness of non-alcoholic beverages for the four groups: $F(3,16) = 3.37$, $p = .042$. The effect size was very large ($\eta_p^2 = .39$). Post hoc comparisons using the Tukey HSD test indicated that the mean score for Group 1 ($M = 4.54$, $SD = 2.04$) was significantly lower than from Group 3 ($M = 8.27$, $SD = 0.81$). Group 2 ($M = 4.50$, $SD = 2.18$) and Group 4 ($M = 5.68$, $SD = 1.59$) did not differ significantly from either Group 1 or 3.

Discussion

This is the first study on cognitive biases in individuals with mild to borderline ID and alcohol use-related problems. The study focused on standardising pictorial stimuli that will be used in the development and validation of alcohol cue reactivity tasks for individuals with mild to borderline ID. Pictures of alcoholic and non-alcoholic beverages were rated on familiarity, complexity, valence and attractiveness as well as brightness and colour (i.e., red, green and blue). The result is a database of 255 pictures of alcoholic and non-alcoholic beverages that are familiar and relatively simple to ensure rapid processing (Alario & Ferrand, 1999; Miller & Fillmore, 2010) and are therefore useful in studying cognitive biases.

Besides standardising the pictures, we also explored group differences between participants with and without a diagnosis of mild to borderline ID and with and without a history of alcohol use-related problems. As there is no theoretical reason why individuals with and without ID should differ on parameters such as familiarity, complexity, valence and attractiveness we did not expect to find any differences between the two groups. The results were generally supportive of the hypothesis. Although there were no differences between individuals with and without ID on familiarity, complexity and valence, there was a significant difference on attractiveness of alcoholic beverages. Individuals with mild to borderline ID rated alcoholic beverages as less attractive than individuals without ID, even when controlling for history of alcohol use-related problems. Based on the results of previous research (e.g., Bradley et al., 2008; Mogg et al., 2003; Pulido et al., 2009), individuals with a history of alcohol use-related problems were expected to rate alcoholic beverages as more pleasant and more attractive compared to non-alcoholic beverages. Contrary to our expectation, the results showed no statistical differences when comparing individuals with and without a history of alcohol use-related problems and, in fact, showed a tendency to rate non-alcoholic beverages as more pleasant and attractive.

As the pictures did not differ on brightness or colour, the lack of differences between groups cannot be explained by the perceptual characteristics of the pictures. Limited statistical power because of the small sample size ($N = 40$) may have played a role in limiting the significance of the comparisons between groups. A post hoc power analysis

revealed the power of the conducted statistical analyses was low (.16) and – with power ($1 - \beta$) set at 0.80 and $\alpha = 05$, two-tailed – the sample size would have to increase up to $N = 68$ in order for group differences to reach statistical significance at the .05 level. However, the limited power does not explain the tendency to rate non-alcoholic beverages as more pleasant and more attractive than alcoholic beverages.

Research on cognitive biases in abstinent but former alcohol-dependent patients offers two possible explanations for this result. First, the perceived opportunity to use alcohol in closed facilities is low. This, in turn, influences subsequent craving (Wertz & Sayette, 2001) and the strength of the attentional bias (Field et al., 2011), which are both lower when participants do not expect to actually use alcohol or drugs. The fact that participants were admitted to a *closed* treatment facility where the chance of using alcohol is relatively low, however, does not mean that they were not exposed to alcohol cues in other ways. For example, research has shown that alcohol use is still prevalent in movies (Roberts, Henriksen, & Foehr, 2004). Considering the fact that (young) adults often watch television in their spare time (Roberts, 2000), it is reasonable to assume the participants in the current study were still frequently exposed to alcohol cues, which, in turn, could be associated with craving (Engels, Hermans, Van Baaren, Hollenstein, & Bot, 2009; Larsen, Engels, Granic, & Overbeek, 2009). Another explanation could be that the participants with a history of alcohol use-related problems, who have had extensive treatment, are motivated to stay abstinent. As a result of treatment, they may have developed an active avoiding strategy to suppress craving. In research concerning the attentional bias this is reflected by an avoidance of alcoholic cues in heavy drinkers (e.g., Noel et al., 2006; Stormark, Field, Hugdahl, & Horowitz, 1997; Townshend & Duka, 2007; Vollstädt-Klein, Loeber, Von der Goltz, Mann, & Kiefer, 2009). Similarly, this cognitive strategy could involve a conscious 'devaluating' of alcohol and alcoholic cues – especially because alcohol cues in movies are generally overly positive and little attention is paid to the negative consequences of drinking alcohol (Engels et al., 2009; Roberts et al., 2004).

However, research on cognitive biases using alcohol-dependent as opposed to healthy participants is scarce and even less is known about abstinent drinkers. For example, attractiveness and valence have never been studied in abstinent drinkers before. Moreover, the before mentioned explanations are all based on research on attentional bias and – as measures of different cognitive biases have been found not to be inter-correlated (Ames et al., 2007; Field, Mogg, & Bradley, 2005; Mogg & Bradley, 2002) – it is unsure if these explanations apply to measures of valence and attractiveness. A suggestion for further research is therefore to measure the attentional, approach and evaluative biases in a longitudinal research design. This way, the strength of the cognitive biases can be measured on several occasions, for example while the participants are still drinking alcohol, immediately following detoxification and after several months of treatment. Moreover, including measures of different cognitive biases, similarities and differences between the biases over time can be examined.

In sum, the present study standardised a large number of pictures of alcoholic and non-alcoholic beverages that can be used in alcohol cue reactivity tasks to study cognitive biases in individuals with mild to borderline ID and alcohol use-related problems. The existing research on cognitive biases has not generalised to the subgroup of individuals with ID, but studying these biases seems particularly useful for screening, assessing and treating substance use-related problems in this target group. The long-term objectives of this research project are to validate implicit measures of cognitive biases for alcohol in adults with mild to borderline ID. Using implicit measures, the presence of cognitive biases in attention, evaluation and approach in people with mild to borderline ID and the influence of IQ and other related cognitive functions (e.g., working memory, impulsivity) on these biases will be assessed.

4

Cognitive biases in long-term abstinent problematic drinkers with mild to borderline intellectual disability

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Abstract

The primary aim of the present pilot study was to examine cognitive biases in individuals with mild to borderline intellectual disability (ID) and alcohol use-related problems. Participants (N = 57) performed the approach avoidance task, picture rating task and visual dot probe task, which was combined with eye-tracking methodology. They were admitted to a forensic setting and were all abstinent and undergoing treatment at the time of testing. Three groups were formed based on the severity of alcohol use-related problems as measured by the AUDIT. In line with the expectations, no differences were found between participants based on the severity of their alcohol use-related problems. In addition, three groups were formed based on IQ to assess the relationship between IQ and the strength of the cognitive biases. There were also no differences between individuals with mild or borderline ID and individuals with (below)average IQ on any of the variables. It is concluded that computer tasks such as these can be used in individuals with mild to borderline ID. As the results suggest no influence of IQ on the strength of cognitive biases, this study opens up new opportunities for future research on the application of measuring cognitive biases in screening, diagnosing and treating individuals with mild to borderline ID and alcohol use-related problems.

Introduction

Individuals with mild to borderline intellectual disability (ID) often use alcohol (Didden, Embregts, Van der Toorn, & Laarhoven, 2009). With a prevalence of 0.5–2% of the ID population (Sturmey, Reyer, Lee, & Robek, 2003), these individuals use alcohol at a lower rate than individuals without ID (Emerson & Turnball, 2005). However, alcohol use in individuals with ID is associated with a relatively high risk of alcohol abuse and dependency (Degenhardt, 2000) and more severe adverse consequences (Slayter, 2008) than among individuals without ID. For example, alcohol use is related to problems with work, housing and the social network. Moreover, research indicates that alcohol use in individuals with ID is a risk factor for aggressive and antisocial behaviour and delinquency (Didden et al., 2009). Individuals with ID are therefore at risk for developing alcohol use-related problems after initial alcohol use.

Although several suggestions have been made on how to improve diagnosis and treatment, screening tools and treatment programs developed for individuals without ID are often not useful in the case of ID. In fact, ID is often a contra-indication for treatment in regular addiction treatment facilities. Validated screening tools and effective treatment programs are lacking and the effectiveness of treatment programs has not been systematically evaluated yet. The relatively high prevalence of alcohol use-related problems and subsequent physical, social and psychological problems suggests, however, that developing and validating screening tools and effective therapies in this target group may be useful and, in fact, necessary.

Studying cognitive biases in automatic processes such as attention, stimulus evaluation and action tendencies might solve the existing issues in screening and treatment of alcohol use-related problems in individuals with mild to borderline ID. According to the incentive sensitisation theory (Robinson & Berridge, 1993, 2003, 2008), repeated alcohol use is associated with adaptations within the reward centre of the brain. As a result of these adaptations, alcohol becomes a powerful incentive and related stimuli become associated with the incentive properties of alcohol through a process of classical conditioning. These stimuli acquire 'incentive salience', meaning that they seem attractive, 'grab attention' and elicit approach behaviour. The salience that is attributed to alcohol-related stimuli is at the expense of other available rewarding stimuli in the environment (Goldstein & Volkow, 2002), resulting in cognitive biases in attention, evaluation and approach tendencies that occur outside of awareness. Franken (2003) and Wiers and Stacy (2006) expanded upon this theory, suggesting that cognitive biases play a role both in the *development* of alcohol use-related problems and in the *maintenance* of these problems.

Indeed, research has shown that repeated alcohol use is associated with several biases in cognitive processing, including biases in attention (Loeber et al., 2009b), evaluation (Pulido, Mok, Brown, & Tapert, 2009) and approach tendencies (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011). Heavy drinkers have been shown to respond faster to targets

replacing alcohol-related stimuli than to targets replacing neutral pictures on the visual dot probe task (MacLeod, Mathews, & Tata, 1986), are faster to approach alcohol-related stimuli and slower to avoid these stimuli than neutral stimuli on the approach avoidance task (Rinck & Becker, 2007) and rate alcohol-related pictures more positively than neutral pictures on the picture rating task. A recent advance in the study of cognitive biases is the use of eye tracking methodology. Because eye movements and pupillary responses are direct behavioural manifestations of the allocation of attention (Henderson, 2003), eye tracking is a more sensitive method for studying cognitive biases than computer tasks (Field, Mogg, & Bradley, 2004). Moreover, this method does not rely on the verbal skills of participants and provides continuous and non-invasive indices of attention to visual stimuli. Research using eye tracking has revealed that heavy alcohol users maintain their gaze on alcohol-related pictorial cues longer than non-users (Friese, Bargas-Avila, Hofmann, & Wiers, 2010). It remains unclear whether or not heavy alcohol users also show biases in the initial allocation of attention (Leventhal et al., 2008).

Studying these cognitive biases has several clinical implications for screening and treating alcohol use-related problems. For example, measuring the strength of cognitive biases can be used for screening purposes as the biases have been shown to be reliable and valid indexes of the severity of alcohol use-related problems (Field, Christiansen, Cole, & Goudie, 2007). The strength of cognitive biases prior to treatment may also serve as a predictor of treatment outcome. Individuals with more pronounced biases at baseline might be less likely to achieve abstinence and/or more likely to relapse following treatment (Cox, Hogan, Kristian, & Race, 2002). Moreover, the measurement of cognitive biases may also have utility as an assessment of treatment success as successful treatment of alcohol use-related problems is thought to reduce the strength of cognitive biases (Cox, Pothos, & Hosier, 2007). Abstinent alcoholics undergoing treatment may actually *avoid* alcohol-related stimuli due to newly learned coping strategies and a motivation to stay abstinent following treatment (Volstädt-Klein, Loeber, Von der Goltz, Mann, & Kiefer, 2009). Lastly, a training directly aimed at reducing cognitive biases has recently been developed which is effective in reducing not only cognitive biases (Field et al., 2007), but also craving (Field & Eastwood, 2005), drinking behaviour (Fadardi & Cox, 2009) and relapse following treatment (Wiers et al., 2011).

Although the existence of cognitive biases for alcohol-related cues has been established in individuals without ID, no study has yet assessed whether such biases also exist in individuals with ID and alcohol use-related problems. Considering the clinical implications of measuring cognitive biases, studying individuals with ID provides an opportunity for the development of new methods for assessing the severity of alcohol use-related problems, evaluating treatment success and actually treating individuals with mild to borderline ID and alcohol use-related problems. The primary aim of the present study was therefore to examine cognitive biases in individuals with mild to borderline ID and alcohol use-related problems using three computer tasks.

In line with previous research using abstinent participants who are undergoing treatment at the time of testing (Noel et al., 2006; Townshend & Duka, 2007; Vollstädt-Klein et al., 2009), we expected no significant differences between participants based on the severity of alcohol use-related problems in the past in attention, approach behaviour and evaluation of alcohol and control pictures. We also assessed the similarities and differences between individuals with and without ID on the three computer tasks. In line with previous research (Merrill, 2005), we hypothesised reaction times would differ significantly between individuals with and without ID, whereas we did not expect to find any differences in the manifestation or strength of the cognitive biases. Lastly, the relationship between cognitive biases and craving was examined. As theorised by Robinson and Berridge (2003), higher levels of subjective craving were predicted to be associated with stronger cognitive biases.

Method

Participants

This pilot study was conducted at Forensic Psychiatric Centre (FPC) Oldenkotte. Participants ($N = 57$; 47 men) were involuntary admitted to a forensic psychiatric hospital on behalf of the state. As they were all admitted to a closed treatment facility where alcohol is not available they were abstinent at the time of the experiment. Groups were created based on two criteria: severity of alcohol use-related problems, as measured by the Alcohol Use Disorder Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Dutch translation: Schippers & Broekman, 2010) and IQ. Group characteristics are shown in Table 1. All participants had normal or corrected to normal vision and spoke fluent Dutch. Groups did not differ on gender ratio (severity of alcohol use-related problems: $\chi^2(2, N = 57) = 1.19$, $p = .553$; IQ: $\chi^2(2, N = 57) = 0.31$, $p = .858$), age (severity of alcohol use-related problems: $F(2,35) = 0.45$, $p = .640$; IQ: $F(2,54) = 0.90$, $p = .413$) and number of months abstinent (severity of alcohol use-related problems $F(2,54) = 1.37$, $p = .263$; IQ: $F(2,54) = 1.99$, $p = .146$). IQ and severity of alcohol use-related problems did differ between groups (Total IQ: $F(2,35) = 69.23$, $p < .001$; Verbal IQ: $F(2,33) = 35.22$, $p < .001$; Performance IQ: $F(2,33) = 49.41$, $p < .001$; AUDIT: $F(2,54) = 69.36$, $p < .001$). A post hoc analysis of planned comparisons revealed that all groups differed significantly from each other. The study was approved by the Ethics Committee of the Faculty of Social Sciences, Radboud University Nijmegen, the Netherlands.

Material

The stimuli for the tasks (see Fig. 1) were derived from our previous study (Van Duijvenbode, Didden, Bloemsaat, & Engels, 2012a). In this study, pictorial stimuli of both alcoholic and non-alcoholic beverages were standardised for individuals with mild to

Table 1 Group characteristics (N = 57).

	Severity of alcohol use-related problems			Intelligence quotient		
	Light drinkers	Moderate drinkers	Heavy drinkers	Average IQ	Borderline ID	Mild ID
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
Age	41.25 (11.15)	38.07 (9.27)	39.23 (9.75)	40.22 (10.37)	37.00 (8.88)	42.22 (10.93)
Total IQ	86.77 (16.46)	82.90 (11.80)	82.67 (11.70)	96.35 (7.96)	78.14 (4.19)	66.43 (3.69)
Verbal IQ	85.77 (17.37)	85.60 (15.38)	86.85 (10.97)	97.88 (10.64)	81.14 (5.53)	66.33 (6.38)
Performance IQ	84.85 (16.58)	83.10 (11.14)	83.23 (12.74)	96.38 (8.26)	75.86 (5.91)	68.67 (4.93)
AUDIT score	2.65 (2.18)	10.67 (2.80)	22.50 (8.26)	12.78 (10.30)	11.25 (8.79)	13.22 (12.95)
Number of months abstinent	42.20 (29.50)	49.93 (33.12)	59.05 (35.86)	43.16 (30.27)	59.25 (34.66)	62.56 (37.41)

Note. AUDIT = Alcohol Use Disorder Identification Test (Babor et al., 2001).

borderline ID. An additional 38 neutral pictures were used as practice and buffer trials in the visual dot probe and approach avoidance task. A different set of pictures was used for every task.

Using independent-samples *t*-tests, differences were assessed between alcohol ($N = 48$) and non-alcohol control pictures ($N = 52$) on attractiveness, complexity, familiarity, valence, brightness and colour (blue, green and red). Between the three tasks, alcohol and control pictures differed significantly on attractiveness (AAT: $t(48) = 8.93$, $p < .001$; PRT: $t(48) = 12.15$, $p < .001$; VDP: $t(48) = 9.69$, $p < .001$) and valence (AAT: $t(48) = 4.33$, $p < .001$; PRT: $t(48) = 5.26$, $p < .001$; VDP: $t(48) = 3.80$, $p < .001$). The non-alcohol control pictures were rated as more attractive and positively valenced compared to the alcohol pictures. There were no significant differences on complexity, familiarity, brightness or colour between the alcohol and control pictures. Moreover, there were no significant differences between the three computer tasks on any of the parameters (see Table 2).

Figure 1 Sample of the pictorial stimuli. Derived from Van Duijvenbode et al. (2012a).

Table 2 Mean parameter ratings of pictures of alcoholic (N = 48) and bon-alcoholic beverages (N = 52) by task.

	AAT		PRT		VDP			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*(2,149)	*p*
Attractiveness	3.77	2.73	3.82	2.83	3.66	2.58	0.05	.952
Complexity	1.45	0.25	1.49	0.29	1.53	0.26	0.98	.378
Familiarity	2.76	0.22	2.78	0.22	2.77	0.22	0.10	.901
Valence	0.59	0.79	0.51	0.86	0.34	0.76	1.25	.291
Brightness	228.79	13.72	227.96	16.75	228.88	17.17	0.05	.951
Blue	216.33	18.33	218.90	15.52	217.55	16.98	0.29	.752
Green	223.32	15.12	223.81	16.60	223.47	15.77	0.01	.988
Red	223.84	10.70	223.79	11.49	223.38	12.65	0.02	.977

Note. AAT = Approach Avoidance Task (Rinck & Becker, 2007); PRT = Picture Rating Task; VDP = Visual Dot Probe task (MacLeod et al., 1986).

The tasks were presented on a 17-in. thin film transistor (TFT) flat screen monitor, attached to a three-button response box. Eye movements were recorded during the visual dot probe using a corneal reflection eye tracker (Tobii T120 Eye Tracker, Tobii Technology, Danderyd, Sweden). The Tobii eye-tracking system records movements of both eyes at 60 Hz with an average accuracy of 0.5° visual angle.

Procedure

As there were no pre-defined inclusion criteria, all patients residing in FPC Oldenkotte could participate unless the treatment team decided against it (for example because of the current psychological condition of the patient). Of the 108 patients, 100 were approached by the researcher and 63 agreed to participate. Six participants dropped out prior to testing, leaving a total *N* of 57. After obtaining their written informed consent, appointments were made. The experiment lasted approximately 2 h and 30 min and was spread out across three sessions of 1 h each.

During the first session, participants provided general demographic information. History of alcohol use was assessed using the Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q; VanDerNagel, Kiewik, Van Dijk, De Jong, & Didden, 2011b). The AUDIT (Babor et al., 2001) was used to provide an index for the severity of alcohol use-related problems. Based on the AUDIT score, participants were classified as either light ($n = 19$), moderate ($n = 16$) or heavy drinkers ($n = 22$). A second classification was made according to the IQ of the participants. IQ was assessed using the most recent scores on the WAIS-III-NL (Uterwijk, 2000b) in the participants' file. Based on this information, three groups were made: participants with mild ID (IQ: 50–69; $n = 9$), borderline ID (IQ: 70–85; $n = 16$) or below average/average IQ (IQ ≥ 86; $n = 32$) (American Psychiatric Association, 2000).

The second session consisted of two computer tasks – the visual dot probe (VDP; MacLeod et al., 1986) and the approach avoidance task (AAT; Rinck & Becker, 2007) – and an assessment of craving. Upon arrival in the test environment, participants were seated 60 cm from the computer monitor and the researcher explained the procedure. Participants first practiced with the eye-tracker by completing a standard visual search task. Then, the gaze of each participant was calibrated using a 5-point calibration procedure. Participants were asked to accurately fixate on an expanding–contracting white circle that appeared on a black background. Calibration was repeated until all calibration points were successfully calibrated.

The VDP started after successful calibration. Each trial started with a central fixation cross, which was presented for 500 ms on a black background. This was immediately followed by the display of two pictures, one on the left and one on the right side of the screen, for a duration of 2000 ms. On each trial, the pictures portrayed one alcoholic and one non-alcoholic beverage matched for structural content (e.g., size and colour of the object). The pictures were positioned in such a way that their inner edges were 30mm apart.

After picture offset, a dot probe (white dot) appeared on either the left or the right side of the screen until the participants' response. Participants were instructed to indicate the position of the probe as quickly as possible by pressing a button on the response box. There was a 1000 ms inter-trial interval before the next trial started. The task consisted of 30 practice trials followed by four blocks of two buffer trials and 25 critical trials. Neutral pictures were used for the practice and buffer trials. The critical trials consisted of the alcohol pictures and their matched non-alcohol control pictures. Each picture appeared twice on the left and twice on the right side of the computer screen, thus appearing four times throughout the task. Trials were randomly presented to each participant. The probe location (left or right) and type of picture replaced by the probe (alcohol or control) were fully counterbalanced.

Participants then completed the AAT. In this task, pictures of both alcoholic and non-alcoholic beverages with a blue or yellow frame were presented in the centre of the screen. Participants were instructed to respond to the colour of the frame as quickly and accurately as possible by moving a joystick either towards or away from themselves. The instructions were counterbalanced across participants; half of the participants pulled pictures with a yellow frame towards them and the other half pulled the pictures with a blue frame towards them. The joystick was positioned on and secured to the table in such a way that movement of the joystick would represent moving the object towards or away from the body. To add to the sensation of approach and avoidance (Neumann & Strack, 2000) and to increase the ecological validity (Rinck & Becker, 2007), the task had a zooming feature, where the stimulus size increased or decreased depending on the movement of the participant. As in Rinck and Becker (2007), seven different sizes (76 x 95, 152 x 190, 228 x 285, 304 x 380, 380 x 475, 456 x 570 and 532 x 665 pixels) of each picture were created to allow for this zooming effect. The size of the picture presented on the screen depended on the position of the joystick. At the start of the trial, the picture size was 304 x 380 pixels. Pushing or pulling the joystick approximately 7°, 15° or 22° resulted in a decrease or increase of the picture size. Finally, the picture disappeared when the joystick had reached an angle of approximately 30°. The picture only disappeared when the joystick was moved in the correct direction. If the participant moved the joystick in the wrong direction, the picture remained on the screen in the smallest or biggest size, depending on the movement. After the picture disappeared from the screen, a new trial started as soon as the joystick was positioned in the central position and the participant pressed the ''trigger'' button. The task consisted of four blocks of two buffer and 25 critical trials preceded by an extensive practice block of 30 trials. As in the VDP, neutral pictures were used in the practice and buffer trials. The critical trials consisted of 25 alcohol pictures and 25 non-alcohol control pictures. Each picture was presented twice – once with a yellow frame and once with a blue frame – resulting in a total of 100 trials. They were presented in a random order for each participant with the restriction that no more than three pictures of the same type (alcohol or control) or same required response (push or pull) were presented successively.

After completion of the computer tasks, participants were asked to rate their current level of alcohol craving. Two paper and pencil measures were used, the order of which was counterbalanced across participants. Craving was measured using an anchored visual analogue scale (VAS) ranging from 0 (*not at all*) to 10 (*extremely).* In addition, an adapted version of the Alcohol Craving Questionnaire Short Form Revised (ACQ-SF-R; Singleton, Tiffany, & Henningfield, 1994) was used. The ACQ-SF-R contains 12 items that are derived from and correlate strongly with the 47-item Alcohol Craving Questionnaire (ACQ-NOW; Singleton et al., 1994). In the current study, the Cronbach alpha coefficient was .89. The adaptations included changing the layout of the questionnaire using small, separate boxes that could be ticked by the participants. Moreover, based on previous research (Bailey, Willner, & Dymond, 2011), a visual aid was included to help decision making (see Fig. 2).

Figure 2 Example of a question and the response options on the Alcohol Craving Questionnaire Short Form Revised (ACQ-SF-R; Singleton et al., 1994).

	Strongly disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**
					
1) I would not enjoy drinking right now.	○	○	○	○	○

The third and final session consisted of the picture rating task (PRT) and an adapted version of the alcohol Stroop task[1]. In the PRT, a fixation cross appeared for 500 ms after which 50 pictures of both alcoholic (N = 25) and non-alcoholic (N = 25) beverages were shown on a white background. The pictures were presented one at a time and in a random order for each participant. Participants were instructed to view the pictures carefully and to rate the pleasantness of each picture on a 6-point rating scale ranging from 0 (*very unpleasant*) to 5 (*very pleasant*). Participants then rated their current level of alcohol craving using both a VAS and the ACQ-SF-R. For this point of measurement, the Cronbach alpha coefficient of the ACQ-SF-R was .92. Finally, participants were told they would receive a full debriefing after completion of the entire study. They were thanked for their time and received €5 for their participation.

Preparation of the data

The eye-tracking data were analysed using a one-way ANOVA. Three dependent variables were used: number of fixations, latency of initial fixations and total amount of time fixating on alcohol and control pictures during critical trials of the visual dot probe task ("dwell time"). Fixations on either the alcohol or control picture were identified if the participant fixated on the fixation cross before picture onset and shifted his gaze to one of the pictures at least 100 ms after picture onset and before picture offset. If the gaze was directed at the position of one of the pictures before picture onset, this was only scored as a fixation if the participant focused on this spot for longer than 150 ms (Field & Cox, 2008). A direction bias score – the percentage of trials in which the initial fixation was on an alcohol picture – was then calculated for each participant. Scores higher than 50% reflected a tendency to direct attention towards alcohol pictures relative to control pictures (Mogg, Bradley, Field, & De Houwer, 2003). "Dwell time" reflected the total amount of time a participant looked at each picture at each trial and was calculated by summing the duration of fixations on the picture. Trials with missing data at least 3 *SD*s above the sample mean were excluded from analyses (Field et al., 2004). Missing data included saccadic shift, eye blinks and failures of the equipment to record data.

Results

Eye-tracking data

The eye-tracking data were analysed using one-way ANOVAs with number of fixations, latency of initial fixations and total fixation time on alcohol and control pictures as the dependent variables. Due to technical problems of the Tobii, data of only 30 participants could be used for analysis. Therefore, we created two groups based on the severity of alcohol use-related problems by using median split. An independent-samples *t*-test indicated a significant difference in AUDIT scores for the heavy drinking ($n = 15$, $M = 22.2$, $SD = 8.09$) and the light drinking group ($n = 15$, $M = 3.53$, $SD = 3.52$); $t(28) = -8.19$, $p < .001$. Likewise, two groups were compared based on IQ (average IQ; $n = 16$ vs. mild to borderline ID; $n = 14$). IQ did not differ significantly between the two groups. However, verbal IQ and performance IQ did approach statistical significance; $t(28) = -1.85$, $p = .075$ and $t(28) = -1.86$, $p = .073$.

As shown in Table 3, there were no significant differences on any of the dependent eye tracking variables. Participants did not fixate on or spend more time looking at one picture more often than the other, nor did they fixate on one picture faster than the other.

Table 3 ANOVA results per participant group.

	Severity of alcohol use-related problems		Intelligence quotient	
	F(1,50)	*p*	*F*(1,50)	*p*
Number of fixations				
Picture type	0.36	.556	0.26	.614
Picture type x group	1.68	.205	3.35	.945
Latency of initial fixation				
Picture type	0.87	.358	0.13	.720
Picture type x group	1.07	.311	1.91	.179
Fixation duration				
Picture type			0.00	.954
Picture type x group			2.72	.111
AAT				
Picture type	199.93	< .001	0.00	.965
Response direction	3.32	.074	1.20	.279
Picture type x response direction x group	0.16	.434	1.53	.227
PRT				
Picture type	54.07	< .001	25.10	< .001
Picture type x group	0.05	.949	0.07	.934
VDP				
Probe position	1.94	.169	0.17	.682
Probe position x group	0.14	.866	2.06	.138

Note. AAT = Approach Avoidance Task (Rinck & Becker, 2007); PRT = Picture Rating Task; VDP = Visual Dot Probe task (MacLeod et al., 1986).

Approach avoidance task

Reaction time (RT) data from buffer trials and outliers (RTs below 200 ms, above 2000 ms and more than 3 *SD*s above the mean) were excluded from analyses (4% of the data). Data were analysed using a 3 x 2 x 2 x 2 mixed design ANOVA with group (light vs. moderate vs. heavy drinkers; average IQ vs. borderline ID vs. mild ID respectively) and version (pull yellow frame vs. push yellow frame) as the between-subjects factors and stimulus type (alcohol vs. control pictures) and response type (approach vs. avoidance) as the within-subjects factors.

When comparing participants based on the severity of alcohol use-related problems, there was a main effect for picture type ($F(1,50) = 199.93$, $p < .001$, $\eta_p^2 = .80$). Overall, participants responded faster to control pictures ($M = 829.58$, $SD = 217.64$; see also Table 4) than to alcoholic ones ($M = 840.55$, $SD = 222.80$). When classifying participants according to their IQ, this result disappeared ($F < 1$). The main effect of response type and the picture type x response direction x group interaction did not reach statistical significance in either group.

Table 4 Mean (M) and standard deviation (SD) of the rating of alcohol and soda pictures on the picture rating task and reaction time on the approach avoidance task and visual dot probe task per participant group.

		AAT				PRT				VDP			
		Alcohol		Soda		Alcohol		Soda		Alcohol		Soda	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
AUDIT scores													
Light drinkers	19	876.34	267.66	858.60	267.45	2.46	1.02	3.97	0.58	474.10	118.10	463.04	135.25
Moderate drinkers	16	857.37	220.01	834.26	204.40	2.69	1.10	4.30	0.60	549.01	205.59	541.22	202.96
Heavy drinkers	22	798.31	188.33	803.03	188.59	2.54	1.15	3.99	0.68	514.43	100.83	510.24	100.00
Total	57	841.60	224.82	830.25	219.55	2.55	1.08	4.06	0.63	510.66	142.00	503.24	145.90
IQ													
Average IQ	32	814.63	210.94	801.68	212.98	2.46	0.89	3.99	0.61	475.10	108.15	458.46	103.22
Borderline ID	16	867.06	202.34	859.18	194.58	2.77	1.24	4.19	0.59	572.90	202.83	578.84	211.02
Mild ID	9	885.58	303.20	876.17	278.40	2.52	1.37	4.10	0.77	542.75	78.69	545.48	67.50
Total	57	840.55	222.80	829.58	217.64	2.56	1.07	4.06	0.63	512.17	141.15	504.69	144.97

Note. AAT = Approach Avoidance Task (Rinck & Becker, 2007); PRT = Picture Rating Task; VDP = Visual Dot Probe task (MacLeod et al., 1986).

Picture rating task

A 3 x 2 ANOVA with group (light vs. moderate vs. heavy drinkers; average IQ vs. borderline ID vs. mild ID respectively) and picture type (alcohol vs. control pictures) as the independent variables revealed that, overall, non-alcohol control pictures were rated as significantly more pleasant than alcohol pictures ($F(1,51) = 54.07$, $p < .001$, $\eta_p^2 = .52$ respectively $F(1,51) = 25.10$, $p < .001$, $\eta_p^2 = .33$). Non-alcoholic beverages were rated as positive ($M = 4.06$, $SD = 0.63$), while alcoholic beverages were rated as neutral ($M = 2.55$, $SD = 1.08$). However, there were no significant differences between the groups on mean pleasantness ratings of alcohol or control pictures.

Visual dot probe

Consistent with previous research (e.g., Bradley, Field, Healy, & Mogg, 2008; Mogg, Field, & Bradley, 2005) RT data from buffer trials and trials with errors (< 1% of the data) were discarded. RTs below 200 ms, above 2000 ms or more than 3 *SD*s above each participant's mean were excluded (2% of the data). Data of one participant were removed from analyses due to a disproportionally high rate of errors (75%).

A 3 x 2 mixed design ANOVA was carried out on the remaining data with group (light vs. moderate vs. heavy drinkers; average IQ vs. borderline ID vs. mild ID respectively) and probe position (probe replacing alcohol picture vs. probe replacing control picture) as independent variables. The groups did not differ on number of errors ($F < 1$) or outliers ($F(2,52) = 2.06$, $p = .137$; $F < 1$ respectively). Although heavy, moderate and light drinkers did not differ significantly on overall mean RT ($F(2,52) = 1.215$, $p = .305$), there was a significant difference based on IQ ($F(2,53) = 3.70$, $p = .031$). Post hoc comparisons using the Tukey HSD test indicated that the mean RT for individuals with average IQ ($M = 466.78$, $SD = 103.28$) was significantly lower than the mean RT for individuals with borderline ID ($M = 575.87$, $SD = 206.52$). Individuals with mild ID ($M = 544.11$, $SD = 72.08$) did not differ significantly from either individuals with average IQ or borderline ID. There was no significant main effect for probe position, indicating that participants did not respond faster to probes replacing alcohol pictures than control pictures. The probe position x group interaction did not reach statistical significance either.

Correlations

Pearson correlations were calculated between attentional and approach bias scores, pleasantness ratings of alcohol pictures, AUDIT scores and craving (VAS and ACQ-SF-R). The two measures of craving correlated significantly with each other on both points of measurement ($r = .67$, $p < .001$; $r = .85$, $p < .001$ respectively). Craving was also positively associated with AUDIT scores (ACQ_1: $r = .26$, $p = .049$; ACQ_2: $r = .29$, $p = .031$; VAS_1: $r = .27$, $p = .044$; VAS_2: $r = .38$, $p = .005$). The pleasantness ratings of alcohol pictures correlated significantly with craving (ACQ_2: $r = .49$, $p < .001$; VAS_2: $r = .45$, $p < .001$) and attentional bias scores ($r = .42$, $p = .002$).

With regard to IQ, the approach bias score for control pictures was positively associated with both total IQ ($r = .40$, $p = .013$) and performance IQ ($r = .56$, $p < .001$). The approach bias score for alcohol pictures was also associated with performance IQ ($r = .34$, $p = .044$) but not with total IQ ($r = .23$, $p = .175$).

Discussion

Although studies on the role of cognitive biases in the development and maintenance of alcohol use-related problems in individuals with average IQ have been blooming, this research has not generalised to individuals with mild to borderline ID yet. Considering the clinical implications of measuring cognitive biases for screening, assessment and treatment evaluation, however, this research is highly needed. The primary aim of the present study was therefore to examine cognitive biases in individuals with mild to borderline ID and alcohol use-related problems.

In line with our expectations, we found no significant differences in cognitive biases between participants based on the severity of their alcohol use-related problems. There was actually a tendency for participants to show cognitive biases *away* from alcoholic beverages, meaning an *avoidance* of alcoholic cues. Similar results have been found in research using abstinent alcoholics undergoing treatment (e.g., Van Duijvenbode et al., 2012a; Noel et al., 2006; Townshend & Duka, 2007; Vollstädt-Klein et al., 2009). Indeed, research on former alcoholics (Cox et al., 2002), but also smokers (Ehrman et al., 2002) and opiate users (Constantinou et al., 2010), suggests that successful treatment is associated with a reduction in the strength of cognitive biases.

A second aim was to assess the relationship between IQ and the strength of the cognitive biases. No differences were found between individuals with mild or borderline ID and individuals with (below) average IQ on any of the variables. It is therefore concluded that IQ does not appear to be associated with strength of cognitive biases, which, in turn, means that based on our results there is no reason to assume that the results of earlier studies on cognitive biases do not apply to individuals with mild to borderline IQ and alcohol use-related problems. As cognitive biases are a reliable and valid index for the severity of alcohol use-related problems (Field et al., 2007), predictive of relapse after treatment (Cox et al., 2002) and can be directly trained away (Wiers et al., 2011), this opens up new possibilities for treating alcohol use-related problems in individuals with mild to borderline ID.

This study had several limitations. The sample size of the current study was small and statistical power was limited. Moreover, there are no valid cut off scores for the AUDIT (Babor et al., 2001) for individuals with mild to borderline ID yet and as participants were all abstinent at the time of testing, it has to be established whether or not the AUDIT scores can be used for these purposes. Lastly, tasks were completed in a fixed order.

Future studies may wish to present the tasks and the assessment of craving in a counterbalanced order to avoid potential order effects.

In summary, computer tasks such as the visual dot probe (MacLeod et al., 1986), the picture rating task and the approach avoidance task (Rinck & Becker, 2007) can be used in individuals with mild to borderline ID. The results of the current study suggest no influence of IQ on the strength of cognitive biases, which opens up new opportunities for future research on the application of measuring cognitive biases in screening, diagnosing and treating individuals with mild to borderline ID and alcohol use-related problems. Although we found no differences between participants based on severity of alcohol use-related problems, this can be explained by the characteristics of the population (i.e., abstinent and undergoing treatment). Taking into account the limitations of the current study, it is advised to replicate these results in future research.

Footnotes

[1] Results of the adapted version of the alcohol Stroop task will not be discussed due to a high mean error rate (19.3%) and missing data of six participants due to technical problems. Details of the task and the results are available upon request from the authors.

5

Cognitive biases in problematic drinkers with mild to borderline intellectual disability

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Abstract

Substance use disorders (SUD) are associated with several neurobiological disruptions, including biases in attention and approach/avoidance behaviour. The aims of this study were to compare the strength of cognitive biases between light and problematic drinkers, to explore the role of IQ on the cognitive biases and to study the psychometric qualities of the measures. Participants (N = 130) were divided into four groups based on IQ and severity of alcohol use-related problems: light (n = 28) and problematic drinkers (n = 25) with (sub)average IQ and light (n = 33) and problematic drinkers (n = 44) with mild to borderline intellectual disability (MBID). All participants performed the visual dot probe task and the approach avoidance task to measure the strength of cognitive biases. In contrast with the hypothesis, no cognitive biases were found in problematic drinkers. Full scale IQ nor level of craving influenced the strength of the cognitive biases in light and problematic drinkers, although IQ did influence task performance (i.e., large intra-individual, trial-to-trial variation in reaction time). The internal consistency of the visual dot probe task was good, whereas the internal consistency of the approach avoidance task was poor. Cognitive biases seem to vary within the group of problematic drinkers as a whole. The psychometric qualities of the measures are problematic, especially in relation to the intra-individual variability in reaction time found in participants with MBID. Until the implications of this variability on the validity of implicit measures and establishing bias scores are more clear, the use of these measures in individuals with MBID calls for scrutiny.

Introduction

One of the central tenets of substance use disorder (SUD) is a loss of control over the alcohol or drug use. In the DSM-V criteria for SUD this is reflected as continued substance use (SU) despite awareness of the negative physical, psychological and interpersonal consequences that are caused or exacerbated by SU (American Psychiatric Association [APA], 2013). As Wiers & Stacy (2013, p. 292) note '… the typical problem in addiction is not that drug abusers do not realise that the disadvantages of continued drug use outweigh the advantages. The central paradox in addictive behaviours is that people continue to use substances even though they know the harm'. Throughout the years this 'paradox of addiction' has been explained as a sign of moral weakness, a symptom of an underlying neurosis or personality disorder or a distinct disease caused by premorbid biological and psychological characteristics of the addicted individual. Around 1990 there was (another) paradigm shift, as researchers began to explore the neurobiological consequences of chronic and/or excessive SU (Leshner, 1997).

According to these researchers, the 'paradox of addiction' could be explained by neurobiological disruptions or cognitive biases in brain regions important to the motivational, reward and inhibitory control processes (Koob, 2013; Volkow, Wang, Tomasi, & Baler, 2013). For example, as a result of chronic and/or excessive SU, the rewarding effects of a substance and related stimuli (e.g. persons, places, thoughts or feelings associated with SU, drug paraphernalia) become overvalued at the expense of other rewards (Hyman, Malenka, & Nestler, 2006; Nestler, 2005). Robinson & Berridge (2008) have called this 'incentive salience' or cognitive biases, meaning they seem attractive, 'grab attention' and elicit approach behaviour. These biases increase in strength with a high level of craving (Field, Munafo, & Franken, 2008). Chronic and/or excessive SU also leads to a disrupted inhibitory control system and reduced top-down control over behaviour (Dackis & O'Brien, 2014; Hyman et al., 2006). For example, SUD is associated with a smaller working memory capacity, a larger delay of gratification and less behavioural control (Hyman et al., 2006). Taken together, these disruptions contribute significantly to the loss of control over SU as alcohol consumption is increasingly influenced by automatic processes that cannot easily be controlled and sometimes even occur outside of conscious awareness.

In addition to providing a theoretical framework for understanding SUD, measuring cognitive biases also has important practical implications (Stacy & Wiers, 2008). For example, as stronger cognitive biases are usually seen in individuals with more severe SUD (Bearre, Sturt, Bruce, & Jones, 2007; Fadardi & Cox, 2012), measures of cognitive biases could potentially be used as screening or assessment instruments for the severity of SUD. A number of studies have also suggested that these measures can be used to predict treatment outcome (e.g. Carpenter, Schreiber, Church, & McDowell, 2006; Marissen et al., 2006). More recently, studies have focused on directly manipulating the cognitive biases by way of training. Results have shown that repeated training reduces the cognitive biases

and leads to behavioural changes such as reductions in drinking and a reduced risk of relapse (Wiers, Gladwin, Hofman, Salemink, & Ridderinkhof, 2013).

However, research on cognitive biases has not yet generalised to problematic drinkers with mild to borderline intellectual disability (MBID; IQ 50–85, APA, 2013). Thus, little is known about the nature and extent of cognitive biases in this target group as well as the possible influence of IQ on the manifestation of these biases (Van Duijvenbode, Didden, Voogd, Korzilius, & Engels, 2012b; Van Duijvenbode et al., 2015). This research could fill an important niche, because (1) individuals with MBID have been identified as a risk group for more negative consequences of SU (Slayter, 2008) and for developing SUD (Burgard, Donohue, Azrin, & Teichner, 2000; McGillicuddy, 2006), (2) adequate screening and assessment instruments and effective treatment interventions for SUD in individuals with MBID are lacking, and (3) measures for cognitive biases do not rely on verbal capacity or insight of clients into the severity of their SUD, are generally easy to conduct and are less susceptible to social desirability (Van Duijvenbode, VanDerNagel, & Didden, 2014). Indeed, results of a pilot study suggest that computerised measures of cognitive biases – such as the visual dot probe task (VDP; MacLeod, Mathews, & Tata, 1986) and the approach avoidance task (AAT; Rinck & Becker, 2007) – are applicable and feasible in individuals with MBID. In addition, the results of this study indicated no influence of IQ on the strength and manifestation of cognitive biases when comparing participants with and without MBID (Van Duijvenbode et al., 2012b), but limitations of this pilot study (e.g. limited power, use of long-term abstinent problematic drinkers) warrant further testing. In the present study we want to expand the findings from this pilot study by including currently drinking participants as opposed to abstinent participants with a history of problematic drinking.

The aim of our study was threefold. First, we aimed to compare the strength of cognitive biases between light and problematic drinkers. In line with previous research on cognitive biases in problematic drinkers, we hypothesised that problematic drinkers would show attentional and approach biases and that these biases would be significantly stronger in problematic drinkers compared to light drinkers. Second, we wanted to explore the role of IQ by including participants with and without MBID. Based on the results of our pilot study with abstaining participants we hypothesised no influence of IQ on the strength or manifestation of cognitive biases (Van Duijvenbode et al., 2012b). Third and last, we wanted to explore the psychometric qualities of the measures and task performance of the participants. In line with earlier critique of Ataya et al. (2012a, 2012b) and Field and Christiansen (2012), we hypothesised the measures to have poor internal consistency. In addition to the internal consistency, we also wanted to study task performance, especially of individuals with MBID as they have been shown to have a slower overall reaction time (RT) and greater variability in their RT (Deary, Der, & Ford, 2001; Hunt, 2005; Jensen, 2006). We therefore also studied intra-individual, trial-to-trial variability in RT – especially in relation to IQ.

Method

Participants

Participants ($N = 130$; 88 men) had a mean age of 33.9 years ($SD = 12.3$). The majority of participants had completed some form of education, most often primary school (22.3%, $n = 29$), special education (23.1%, $n = 30$) or secondary school (18.5%, $n = 24$). Nine participants (6.9%) had not finished primary school and 20 participants (15.4%) still attended vocational school or university (college). All participants had normal or corrected to normal vision and spoke Dutch fluently. All participants had the Dutch nationality and the majority (91.5%, $n = 119$) originated from the Netherlands. The other participants originated from Surinam/The Antilles (3.8%, $n = 5$), Morocco/Turkey (1.6%, $n = 2$) or other Western and non-Western countries (3.1%, $n = 4$).

The majority of the participants (90.0%, $n = 91$) received outpatient or residential care from organisations within ID care ($n = 64$) or addiction medicine ($n = 27$) at the time of the study. All participants had access to alcohol. Seventy-four participants were diagnosed by the treatment team with one or more psychiatric disorders. SUD (30.8%, $n = 40$), autism spectrum disorder (10.8%, $n = 14$) and attention deficit hyperactivity disorder (8.5%, $n = 11$) were diagnosed most often. Nineteen participants were also diagnosed with one or more personality disorders, most often a cluster B personality disorder (i.e. antisocial, borderline or narcissistic personality disorder, 9.2%, $n = 12$) or a personality disorder not otherwise specified (7.7%, $n = 10$).

Material

Cognitive biases

Cognitive biases were measured by two computerised measures: the VDP and the AAT (for a detailed description of the tasks, see Van Duijvenbode et al., 2012b). Both tasks were presented on a 17-inch thin film transistor (TFT) flat screen monitor.

The VDP (MacLeod et al., 1986) was used to measure the attentional bias. In each trial, two pictures of one alcoholic and one non-alcoholic beverage were presented on the left and the right side of the screen. Both pictures were matched for structural content, such as size and colour. After the pictures disappeared, a dot probe (white dot) appeared on either the left or the right side of the screen (see Figure 1A). Participants were instructed to indicate the position of the probe as quickly as possible by pressing a button on the response box. The RT in ms to respond to the dot probe was recorded as the dependent variable. An attentional bias score was then calculated by subtracting the RT of trials in which the dot probe replaced the alcoholic beverage from the RT of trials in which the dot probe replaced the non-alcoholic beverage ($RT_{sod} - RT_{alc}$). A positive score is indicative of an attentional bias towards alcohol, while a negative score indicates a bias away from alcohol (Loeber et al., 2009b).

The AAT (Rinck & Becker, 2007) was used to measure automatic approach/avoidance tendencies. In this task, pictures of alcoholic and non-alcoholic beverages with a yellow or blue frame were presented in the centre of the screen (see Figure 1B). Participants were instructed to respond to the colour of the frame as quickly and accurately as possible by

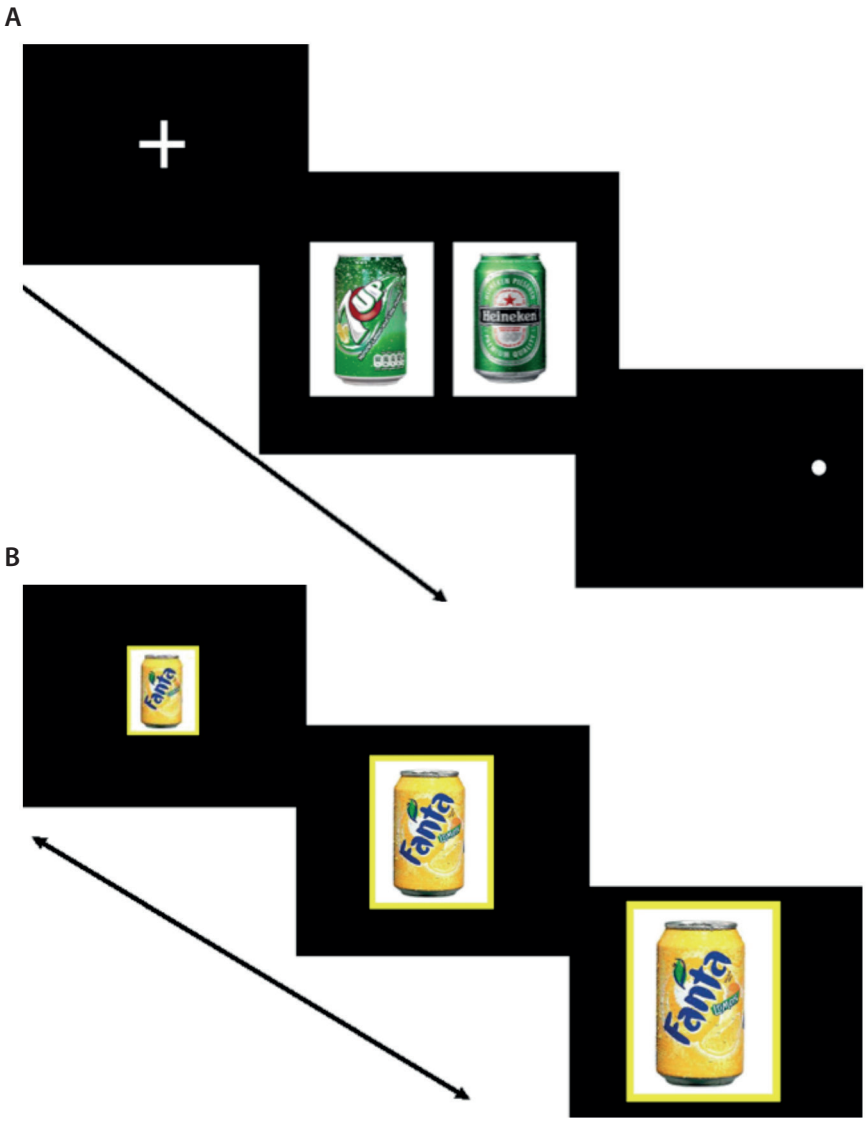

Figure 1 Schematic overview of (**A**) the Visual Dot Probe Task (VDP; MacLeod et al., 1986) and (**B**) *the Approach Avoidance Task* (AAT; Rinck & Becker, 2007).

moving a joystick either towards or away from themselves. The instructions were counterbalanced across participants. Depending on the movement of the joystick, the picture size increased or decreased, thereby adding to the sensation of approach/avoidance (Neumann & Strack, 2000) and increasing the ecological validity of the task (Rinck & Becker, 2007). An approach bias score for both alcoholic as well as non-alcoholic beverages was calculated by subtracting the approach RT from the avoid RT ($RT_{avoid} - RT_{approach}$). A positive score indicates an approach bias towards alcohol, while a negative score indicates a bias away from alcohol (Cousijn, Luijten, & Wiers, 2014).

Substance use

The general pattern of alcohol use was assessed using the Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q; VanDerNagel, Kiewik, Van Dijk, De Jong, & Didden, 2011b; VanDerNagel, Kemna, & Didden, 2013), a Dutch-language instrument to assess SU, risk factors for SUD and consequences of SU(D) in individuals with MBID. All participants reported their general frequency and quantity of alcohol use. The data provided by the participants were then converted into standard units of 10g of alcohol (International Center for Alcohol Policies, 2010).

The severity of alcohol use-related problems was measured by the Alcohol Use Disorder Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Dutch translation: Schippers & Broekman, 2010), which is integrated in the SumID-Q. The AUDIT is a standardised questionnaire of 10 questions about the amount, frequency and consequences of drinking alcohol. Scores range between 0 and 40, with higher scores reflecting more severe alcohol use-related problems. A score of 8 or more indicates hazardous alcohol use (Babor et al., 2001) and was used in this study to classify participants as either light drinkers (score < 8) or problematic drinkers (score ≥ 8).

Craving

Craving was measured by an anchored visual analogue scale (VAS) ranging from 0 (*not at all*) to 10 (*extremely*). This measures was identical to the one used in Van Duijvenbode et al. (2012b) and provides a simple and minimally intrusive measure of craving for alcohol. As suggested in the literature, the VAS included a visual representation of the level of craving by a gradual change of colour from green to red (Hartley & MacLean, 2006). It has been concluded that this type of measurement can be used in individuals with MBID (Prosser & Bromley, 2012).

IQ

IQ was measured using the most recent scores on the Dutch version of the Wechsler Adults Intelligence Scale third edition (WAIS-III-NL; Uterwijk, 2000b) in the participants' files. If IQ was unknown, a short version of the WAIS-III was used ($n = 53$) (Van Duijvenbode, Didden, Van den Hazel, & Engels, 2016a). It was not possible to have all participants take

the full-length WAIS-III because of time-related issues and potential participant fatigue. The short form is based on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) and consists of four subtests: Vocabulary, Similarities, Block design and Matrix reasoning. It can be administered in approximately 30 min and provides a good estimate of full scale IQ in individuals with MBID (Van Duijvenbode et al., 2016a). Full scale IQ was used to classify participants as having MBID (IQ < 85) or (sub)average intellectual functioning (IQ ≥ 85).

Procedure

No systematic sampling method was used to select and recruit participants. Clients receiving care from organisations within ID care or addiction medicine were selected by the treatment team and could participate if they (1) were 18 years or older, (2) had an IQ of minimally 50 and (3) were functioning stably (for example, free from withdrawal symptoms and no active psychotic or manic state as assessed by the treatment team). Abstaining clients with a history of problematic alcohol use were excluded from participating. Participants were also recruited by the first author (NvD) and trained students via advertisements on social media, the Radboud university and word of mouth. A preliminary check was conducted to see if these participants matched the inclusion criteria.

All participants were provided with a folder with general information about the study. They were told they could withdraw at any time during the study without any complications for their treatment and that their information would be analysed anonymously. They were also provided with contact information of the researcher. After obtaining written informed consent of both the clients and their treatment team, appointments were made. The experiment lasted approximately 2 h and was spread out across two sessions of 1 h each with an average time of 1 week between sessions.

During the first session, participants provided general demographic information, followed by an assessment of alcohol and drug use. If necessary, the WAIS-III short form (Van Duijvenbode et al., 2016a) was used to estimate full scale IQ. The second session consisted of the two computer tasks – the VDP and the AAT – and an assessment of craving. In between tasks, participants were allowed to take a break whenever necessary. Finally, participants were told they would receive a full debriefing after completion of the entire study. They were thanked for their time and received a gift worth €5 (US $6.50) for their participation.

The study was approved by the Committee of Ethics of the Faculty of Social Sciences, Radboud University Nijmegen, the Netherlands (ECG2012-1301-003).

Preparation of the data and statistical analysis

As in previous research (e.g. Bradley, Field, Healy, & Mogg, 2008; Cousijn et al., 2014), RT data from buffer trials and trials with errors on the VDP and the AAT were discarded. To minimise the influence of outliers, the median RTs were used instead of the mean RTs,

making it unnecessary to define cut-off points for outliers (Peeters et al., 2012; Rinck & Becker, 2007). Data on the VDP of five participants were missing because of a disproportionally high rate of errors (clicking the wrong button on the response box to indicate the position of the probe). Similarly, data on the AAT of five other participants were also missing because of technical problems.

IBM SPSS Statistics (Version 20) was used to conduct the statistical analyses. Data of the VDP were analysed using a 2 x 2 mixed design ANOVA, with group (light vs. problematic drinkers) and probe position (probe replacing picture of alcoholic beverage vs. probe replacing picture of non-alcoholic beverage) as independent variables. Data of the AAT were analysed using a 2 x 2 x 2 x 2 mixed design ANOVA, with group (light vs. problematic drinkers) and version (pull yellow frame vs. pull blue frame) as between-subjects factors and picture type (alcoholic beverage vs. non-alcoholic beverage) and response direction (approach vs. avoid) as within-subjects factors. A power analysis (with G*Power Version 3.1.92) showed that with the number of participants in the sample ($N = 130$) and the statistical tests used (the most complex ANOVA in the study) a power of .81 was achieved at a medium effect size ($f = .25$) and α of .05. This is above the convention of .80 (Cohen, 1992); therefore the four groups can be expected to be large enough to sufficiently prevent a type II error. The relationship between bias scores, AUDIT score, weekly alcohol consumption, full scale IQ and craving was further investigated using *t*-tests, multiple regression analyses and Pearson product–moment correlation coefficient.

In addition, the psychometric qualities of the VDP and AAT were investigated. Cronbach's alpha was calculated as an index of the internal consistency of RT and bias scores on both tasks as a whole and for each participant group (light and problematic drinkers with and without MBID) and trial category (alcohol and soda trials, push and pull trials) separately. Following Lövdén, Li, Shing and Lindenberger (2007), we studied intra-individual variability in RT by (1) calculating the intra-individual coefficient of variation (CoV; individual *SD* / individual *M*), and (2) using the intra-individual *SD* based on all (correct) responses within each task as a whole.

We used an alpha level of .05 in all statistical analyses except for the hypothesis assuming no influence of IQ on the strength or manifestation of cognitive biases. In testing this hypothesis we used another alpha level in order to avoid making a type II error – not rejecting H_0 when it is false. Type II error (beta level) is conventionally set at .20, and the chances of making this type of error can be decreased by increasing type I error (alpha level) because there is a trade off between the two error types: if alpha increases, beta decreases and vice versa (Field, 2013). Therefore, in line with Kirk (1982) an alpha level .25 was adopted to test this hypothesis.

Results

Group characteristics

Participants were divided into four groups based on AUDIT score and IQ: light drinking participants with (sub)average IQ ($n = 28$), problematic drinking participants with (sub) average IQ ($n = 25$), light drinking participants with MBID ($n = 33$) and problematic drinking participants with MBID ($n = 44$). Group characteristics are shown in Table 1. As expected, a one-way between groups analysis of variance showed that (est.) full scale IQ ($F(3,126) = 111.95$, $p < .001$, $\eta_p^2 = .73$), AUDIT score ($F(3,126) = 68.82$, $p < .001$, $\eta_p^2 = .62$) and weekly alcohol consumption ($F(3,126) = 9.80$, $p < .001$, $\eta_p^2 = .19$) differed significantly between the groups. A post-hoc Tukey HSD test revealed that problematic drinkers in both IQ groups had a higher AUDIT score and consumed more alcohol per week than light drinkers. Similarly, participants with MBID had a significantly lower IQ compared to non-ID participants, irrespective of severity of alcohol use-related problems. Although groups also differed on gender ratio ($\chi^2(3, N = 130) = 17.96$, $p < .001$) – with larger proportions of light drinking compared to problematic drinking women – this was to be expected considering the gender differences in the prevalence of SU(D) (Lev-Ran, Le Strat, Imtiaz, Rehm, & Le Foll, 2013; Seedat et al., 2009). Groups did not differ on cultural background and age ($p > .05$).

Table 1 Participant Characteristics per Group (N = 130); Light Drinkers with (Sub) Average IQ (n = 28), Problematic Drinkers with (Sub)Average IQ (n = 25), Light Drinkers with Mild to Borderline Intellectual Disability (MBID; n = 33) and Problematic Drinkers with MBID (n = 44).

	(Sub)Average IQ		**MBID**	
	Light drinkers	Problematic drinkers	Light drinkers	Problematic drinkers
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*
Age	31.96 (12.78)	33.25 (11.63)	34.67 (12.64)	34.45 (12.51)
Est. full scale IQ	107.29 (12.79)	105.88 (12.72)	71.63 (9.22)	69.31 (9.24)
Est. verbal IQ	103.00 (13.22)	106.17 (15.42)	72.50 (11.80)	69.43 (10.92)
Est. performance IQ	108.93 (13.81)	104.75 (12.53)	70.43 (10.05)	70.43 (10.05)
AUDIT score	3.89 (2.28)	16.79 (7.45)	2.60 (2.19)	17.14 (7.15)
Weekly alcohol consumption	4.30 (5.36)	57.42 (73.50)	1.10 (2.75)	30.47 (48.56)

Note. AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001).

Cognitive biases

Our first hypothesis was that problematic drinkers would show attentional and approach biases and that these biases would be significantly stronger in problematic drinkers compared to light drinkers. A 2 x 2 mixed design ANOVA carried out on the VDP data revealed no significant main effect for probe position ($F(1,124) = 2.79$, $p = .10$), meaning participants did not respond faster to probes replacing pictures of alcoholic beverages than pictures of non-alcoholic beverages. The probe position × group interaction did not reach statistical significance either ($F(1,124) = 1.27$, $p = .26$). Data of the AAT were analysed using a 2 x 2 x 2 x 2 mixed design ANOVA, which showed a significant main effect for picture type ($F(1,120) = 4.62$, $p = .03$, $\eta_p^2 = .04$). Overall, participants responded faster to alcoholic beverages ($M = 777$, $SD = 239$) than to non-alcoholic beverages ($M = 790$, $SD = 222$). All other main effects and the group x version x picture type x response direction interaction did not reach statistical significance ($F(1,120) = 0.22$, $p = .64$). These results maintained after controlling for craving and gender ($F_{VDP}(1,21) = 0.03$, $p = .85$; $F_{AAT}(1,117) = 0.11$, $p = .74$) in a one-way between-groups analysis of covariance.

Furthermore, bias scores were investigated using a one-sample *t*-test to compare the mean bias scores to zero, meaning no bias. Neither the attentional and approach bias score for light drinkers (VDP: $M = 2.57$, $SD = 25.26$, $t(57) = 0.78$, $p = .44$; AAT: $M = 1.09$, $SD = 131.64$, $t(57) = 0.06$, $p = .95$) nor for problematic drinkers (VDP: $M = 12.75$, $SD = 67.94$, $t(67) = 1.55$, $p = .13$; AAT: $M = 29.44$, $SD = 134.80$, $t(65) = 1.77$, $p = .08$) differed significantly from zero. There was also no significant difference in bias scores between the two groups ($t_{VDP}(124) = -1.08$, $p = .28$; $t_{AAT}(122) = -1.18$, $p = .24$). The magnitude of the difference in the means for the attentional bias score (mean difference = -10.18, 95% CI -28.86 to 8.50) and the approach bias score for alcoholic beverages (mean difference = -28.35, 95% CI -75.86 to 19.15) were very small ($\eta_p^2 = .009$; $\eta_p^2 = .011$ respectively).

IQ

Our second hypothesis was that there would be no influence of IQ on the strength or manifestation of cognitive biases. Pearson *r* correlations showed that AUDIT score correlated significantly with the attentional bias score ($r = .19$, $p = .03$) and the approach bias score for alcoholic beverages ($r = .23$, $p = 0.1$), whereas full scale IQ ($r_{VDP} = -.07$, $p = .41$; $r_{AAT} = .01$, $p = .92$), craving ($r_{VDP} = .17$, $p = .06$; $r_{AAT} = .04$, $p = .68$) and weekly alcohol consumption did not ($r_{VDP} = -.03$, $p = .77$; $r_{AAT} = .00$, $p = .99$). These results remained after controlling for gender in a partial correlation analysis. These results were confirmed by multiple regression analyses to assess the ability of AUDIT score, weekly alcohol consumption, full scale IQ and craving to predict the bias scores on the VDP and AAT. When attentional bias score was predicted, it was found that the full model was statistically significant ($F(4,118) = 2.75$, $p = .03$) and explained 29.2% of the variance. AUDIT score ($\beta = .24$, $p = .03$) and weekly alcohol consumption ($\beta = -.24$, $p = .03$) were both significant predictors, while full scale IQ ($\beta = -.04$, $p = .67$) and craving ($\beta = .17$, $p = .10$) were not. The full model for

approach bias for alcoholic beverages on the AAT was also statistically significant ($F(4,116) = 2.51$, $p = .05$) and explained 28.2% of the variance in AAT bias score for alcoholic beverages. AUDIT score ($\beta = .36$, $p = .01$) was the only significant predictor. Full scale IQ ($\beta = .05$, $p = .55$), weekly alcohol consumption ($\beta = -.18$, $p = .11$) and craving ($\beta = -0.4$, $p = .89$) did not make unique contributions to the model. The full model for the AAT bias score for non-alcoholic beverages did not reach statistical significance ($F(4,116) = 1.39$, $p = .24$).

Psychometric qualities

Our third and final hypothesis was that the measures would have poor internal consistency. Internal consistency of the VDP and AAT was assessed by Cronbach's alpha. The internal consistency of the RTs was excellent, reflected by a mean inter-item correlation of .87 and a Cronbach's alpha of .99 for the VDP and a mean inter-item correlation of .34 and a Cronbach's alpha of .97 for the AAT. The internal consistency of the attentional bias scores was good (Cronbach's alpha = .71, mean inter-item correlation = .07). The internal consistency of the approach bias score, on the other hand, was poor (Cronbach's alpha = .58, mean inter-item correlation = .03). These results maintained when exploring each participant group (light and problematic drinkers with and without MBID) and trial category (alcohol and soda trials, push and pull trials) separately.

Last, we explored task performance by studying intra-individual, trial-to-trial variability in RT in relation to IQ. An independent samples *t*-test with equal variances not assumed showed that participants with MBID had a significantly larger overall RT, overall *SD* in RT and intra-individual CoV in RT (individual *SD* / individual *M*) compared to non-ID participants (see Table 2). Pearson correlations showed that full scale IQ correlated negatively with all these parameters, on both the AAT and the VDP (correlations ranging between -.27 and -.57, $p < .001$). These results maintained after controlling for age in a partial correlation analysis.

Table 2 Descriptives and Independent Samples t-Test with Equal Variance not assumed of Reaction Time (RT) and Intra-Individual Variability per Participant Group.

	Participants with MBID		**Participants with (sub)average IQ**				
	M	*SD*	*M*	*SD*	*t*(122)	*p*	η_p^2
AAT							
Overall M RT	874	231	669	138	6.17	<.001	.238
Overall SD of RT	217	109	136	52	5.56	<.001	.202
CoV	0.24	0.07	0.20	0 .05	3.65	<.001	.098
VDP							
Overall M RT	572	201	462	132	3.71	<.001	.098
Overall SD of RT	115	60	82	57	3.13	.002	.072
CoV	0.20	0.07	0.17	0.06	2.60	.011	.051

Note. MBID = Mild to Borderline Intellectual Disability; AAT = Approach Avoidance Task (Rinck & Becker, 2007); VDP = Visual Dot Probe Task (MacLeod et al., 1986); CoV = Coefficient of variation in RT.

Discussion

This is the first study of cognitive biases in problematic drinkers with MBID. The goals of this study were to compare the strength of cognitive biases between light and problematic drinkers, to explore the influence of IQ on the strength and manifestation of cognitive biases and to study the psychometric qualities of the VDP (MacLeod et al., 1986) and AAT (Rinck & Becker, 2007).

Our first hypothesis was that problematic drinkers would show attentional and approach biases and that these biases would be significantly stronger in problematic drinkers compared to light drinkers. In line with previous research (e.g. Field & Cox, 2008), light drinkers showed no attentional or approach bias towards alcohol. In contrast with previous research (e.g., Field, Caren, Fernie, & De Houwer, 2011; Sharbanee, Stritzke, Wiers, & MacLeod, 2013), however, problematic drinkers in this convenience sample showed no attentional or approach bias towards alcohol either, although severity of alcohol use-related problems did make a unique contribution to the prediction of and was significantly correlated with the strength of the cognitive biases. Noteworthy is the large variation in bias scores in problematic drinkers, with some showing an attentional bias *towards* alcohol and others an attentional bias *away from* alcohol. This large variation suggests that problematic drinkers are a heterogeneous group, perhaps as a factor of executive functioning (e.g., working memory, inhibitory control and processing speed), level of craving or motivation to become or remain abstinent (see for example Burton, Pedersen, & McCarthy, 2012; Field, Munafo, & Franken, 2009; Grenard et al., 2008). Another

explanation lies in the characteristics of the participant group with the majority of the participants receiving outpatient or residential care from organisations within ID care or addiction medicine at the time of the study, as attentional avoidance of alcohol cues has been found in problematic drinkers (without MBID) receiving treatment (e.g., Van Duijvenbode et al., 2012a; Noel et al., 2006; Townshend & Duka, 2007; Vollstädt-Klein, Loeber, Von der Goltz, Mann, & Kiefer, 2009).

Our second hypothesis was that there would be no influence of IQ on the strength of manifestation of the cognitive biases. As in our previous pilot study (Van Duijvenbode et al., 2012b), full scale IQ was not associated with the strength or manifestation of the cognitive biases. Yet, IQ does appear to influence task performance. Individuals with MBID showed a slower overall RT and a greater trial-to-trial variability in their RT (see also Deary et al., 2001; Hunt, 2005; Jensen, 2006). Baumeister and Kellas (1968) have associated this variability in RT with a greater difficulty of individuals with MBID to maintain an optimal level of performance, for example because of momentary fluctuations in attention or deficiencies in executive functioning such as working memory or information processing speed (Haishi, Okuzumi, & Kokubun, 2011; Schmiedek, Oberauer, Wilhelm, Süss, & Wittman, 2007). One could argue that RT measures therefore cannot be used when studying individuals with MBID, as RT is inconsistent and therefore relatively meaningless – especially in comparison with other groups. One could also argue that intra-individual variability in RT is a stable characteristic of the individual and should therefore be explored in itself when studying individuals with MBID, for example in relation to concentration span and executive functioning. The implications of intra-individual variability in RT on the validity of RT measures in individuals with MBID thus remain unclear.

Our third and final hypothesis was that the VDP and AAT would have poor internal consistency. As opposed to Ataya et al. (2012a, 2012b) and Field and Christiansen (2012), we found the internal consistency of the attentional bias score to be good as it reached the acceptable level of .70 (DeVellis, 2003). The internal consistency of the approach bias score, on the other hand, was poor. Of importance is the very low mean inter-item correlation ($r < .1$), suggesting poor item homogeneity, irrespective of IQ. Following Field and Christiansen (2012), this might be explained by differences in individual preferences to alcoholic beverages (beer, wine, alcopops and liquor), which could subsequently yield inconsistent bias scores within a task and across participants and thus poor item homogeneity and construct validity.

We note several limitations of this study. First, the majority of the participants were diagnosed with one or more psychiatric disorders and often also used cannabis and other drugs, in addition to drinking alcohol. Furthermore, most of the participants were prescribed medications. Although this co-morbidity between psychiatric disorders, subsequent use of prescribed psychotropic medication and SUD reflects the complex nature of the target group (see for example Center for Substance Abuse Treatment, 2007), a possible influence of these co-morbid disorders on the cognitive biases and the

performance on (the short form of) the WAIS-III (Uterwijk, 2000b; Van Duijvenbode et al., 2016a) cannot be ruled out. One line of future inquiry could therefore be to study the influence of co-morbidity on the strength of cognitive biases, for example by comparing problematic drinkers with poly-substance users and identifying factors that could influence the strength of cognitive biases in problematic drinkers (e.g. executive functioning, motivation to become or remain abstinent). Second, SU was assessed using the SumID-Q (VanDerNagel et al., 2011b) and the severity of alcohol use-related problems was measured by the AUDIT (Babor et al., 2001). Because MBID is associated with memory-related problems (Lifshitz, Shtein, Weiss, & Vakil, 2011), the psychometric qualities of the SumID-Q have not been studied yet and there are no valid cut-off scores for the AUDIT for individuals with MBID, the validity and reliability of these measures in individuals with MBID can be questioned. Research could therefore be directed at validating the SumID-Q and the AUDIT for individuals with MBID. Last, the psychometric qualities and usefulness of implicit measures such as the VDP and AAT remain unclear and need to be examined further, especially in light of the observed intra-individual, trial-to-trial variability in RT in individuals with MBID and the poor item homogeneity of the bias scores. Several suggestions have already been made to improve the validity and reliability of implicit measures, including the use of eye tracking methodology in addition to calculating bias scores, the use of individualised stimuli based on drinking preferences and the use of different ways to calculate bias scores and handling outliers in RT (Ataya et al., 2012a; Field & Christiansen, 2012; Price et al., 2015). Future research could also focus on ways to minimise intra-individual variability in RT, for example by studying optimal task and procedural factors to increase the stability of RT (e.g. providing within-task feedback, using fixed and long preparatory intervals between trials and using simple rather than complex tasks; Dykiert, Der, Starr, & Deary, 2012; Garrett, MacDonald, & Craik, 2012).

To summarise, the nature of implicit tasks (i.e., no reliance on verbal capacity, less susceptible to social desirability and easy to complete; Van Duijvenbode et al., 2014) makes implicit measures look promising for use in individuals with MBID. However, as we found no attentional or approach biases in problematic drinkers with and without MBID, the results of our study call for caution. Cognitive biases seem to vary within the group of problematic drinkers as a whole, perhaps as a function of executive functioning, level of craving or other participant-related factors (e.g., motivation to become or remain abstinent, co-morbid psychiatric disorders and use of prescribed medication). Although full scale IQ does not influence the strength of the cognitive biases, it does appear to influence task performance in the form of a greater intra-individual variability in RT. In future studies, we will examine this variability and the implications it has on for example the validity of RT measures and establishing bias scores further, as well as the relationship between executive functioning, cognitive biases and alcohol use. Until the implications of this variability for example on the validity of RT measures and establishing bias scores are more clear, the use of these measures in individuals with MBID calls for scrutiny.

6

Attentional bias in problematic drinkers with mild to borderline intellectual disability

This chapter has been submitted as:
Van Duijvenbode, N., Didden, R., Korzilius, H. P. L. M., & Engels, R. C. M. E. (submitted).
Attentional bias in problematic drinkers with mild to borderline intellectual disability.

Abstract

Problematic drinkers favour the processing of alcohol-related stimuli at the cost of other stimuli and also find it difficult to disengage their attention from these stimuli. This is indicative of an attentional bias towards alcohol. The goal of this study was to examine this bias in problematic drinkers with and without mild to borderline intellectual disability (MBID) using both eye tracking methodology and behavioural data (i.e., reaction time (RT) data). Participants (N = 133) were divided into four groups based on (estimated) full scale IQ and severity of alcohol use-related problems: light and problematic drinkers with and without MBID. The severity of substance use-related problems was assessed with the AUDIT. The visual dot probe task was used to measure the attentional bias. We analysed both eye tracking data and behavioural data (i.e., RT data) of the visual dot probe task. We found no evidence for an attentional bias in problematic drinkers, irrespective of (estimated) full scale IQ. The strength of the attentional bias varied within the group of problematic drinkers, although this was not correlated significantly with the severity of alcohol use-related problems. These results remained when controlling for (estimated) full scale IQ, gender and current levels of craving. Taking the large variability in the strength of the attentional bias and the poor psychometric qualities of the measures into consideration, it is concluded that the use of these measures for clinical purposes is discouraged.

Introduction

Attention is a limited resource, meaning we are not able to attend to and process all the input from our environment that constantly floods the information processing system. From this it follows that attention involves a selection, where some input is selected for further processing and other input is ignored (Radvansky & Ashcraft, 2014). Part of this selection procedure is driven by characteristics of the stimulus. For example, a sudden loud noise, a moving object in an otherwise still environment or a touch of colour against a clear background will automatically attract the attention. Directing attention in such a reflexive way is called bottom-up or exogenous attentional orienting (Mulckhuyse & Theeuwes, 2010). Another part of the selection procedure is driven by the individual's personal relevance, motives, goals and desires. In other words, highly salient and meaningful information tends to stand out (Le Pelley, Pearson, Griffiths, & Beesley, 2015). An example of this top-down or endogenous attentional orienting (Mulckhuyse & Theeuwes, 2010) is the cocktail party effect, where hearing your name in a noisy environment 'drowns out' other input and is prioritised in the information processing. As opposed to exogenous attentional orienting, endogenous attentional orienting is the result of a quick evaluation of the significance of a stimulus (Everaert, Spruyt, & De Houwer, 2013) and is flexible and dynamic, as motives, goals and desires may change over time and context (Radvansky & Ashcraft, 2014).

As a result of endogenous attentional orienting, attentional biases are developed, which can be defined as a tendency to selectively attend to certain stimuli at the expense of other stimuli. Although this is an adaptive process, the focus of the attention can be problematic – for example in the case of problematic alcohol use. Indeed, research has shown that – within the context of (problematic) alcohol use – the processing of alcohol-related stimuli is favoured at the cost of other stimuli in problematic drinkers. These stimuli not only attract the attention, problematic drinkers also show difficulty disengaging their attention from them (for reviews see Cox, Fadardi, & Pothos, 2006; Field & Cox, 2008; Robbins & Ehrman, 2004). The strength of the attentional bias is generally related to the severity of alcohol use-related problems, with stronger biases reported in problematic drinkers compared to light drinkers and abstaining individuals (Cox et al., 2006). According to the incentive sensitisation theory (Robinson & Berridge, 2003), the attentional bias develops through a process of classical conditioning. After repeated alcohol use, alcohol-related stimuli acquire rewarding properties, become powerful incentives and in such a way guide the attentional orienting. Franken (2003) expanded upon this theory, suggesting that the attentional bias plays a role both in the *development* and in the *maintenance* of problematic alcohol use by a reciprocal relationship between the attentional bias and craving. Indeed, a meta-analysis conducted by Field, Munafo and Franken (2009) indicated a significant, albeit weak, association between the attentional bias and craving.

Two of the most widely used research tools to assess the attentional bias are the addiction Stroop task (Stroop, 1935) and the visual dot probe task (VDP; MacLeod, Mathews, & Tata, 1986). In the addiction Stroop task, participants are presented with alcohol-related and neutral words, printed in different coloured fonts. They are required to identify the colour in which the words are printed as quickly and accurately as possible, while ignoring the content and meaning of the words. In a meta-analysis, Cox et al. (2006) concluded that problematic drinkers are slower in naming the colour of alcohol-related words compared to neutral words, which suggests they are distracted by the content and meaning of the words and is indicative of an attentional bias. In the VDP, participants are presented with two pictorial stimuli simultaneously (i.e., an alcohol-related and a neutral stimulus) that are matched for structural content. After these pictures disappear, a dot probe appears and participants are instructed to indicate the position of the probe as quickly as possible. Using this task, problematic drinkers have been found to respond quicker to dot probes replacing the alcohol-related picture compared to the neutral picture (Field & Cox, 2008), suggesting an attentional bias towards these pictures.

The rationale behind these measurement approaches is that attention is limited and can easily be attracted by relevant and salient stimuli, such as alcohol-related words or pictures (Vollstädt-Klein, Loeber, Von der Goltz, Mann, & Kiefer, 2009). The addiction Stroop task and VDP therefore provide indirect measures of attention selection and allocation, derived from reaction times (RTs). However, RTs provide only a 'snapshot' of attention allocation at the time of the response rather than a continuous measure. They provide little insight in the attention selection and allocation while participants are presented with the stimuli, such as the distinction between biases in initial orienting and in the maintenance or disengagement of attention (Field et al., 2009). In addition, the psychometric qualities of both the addiction Stroop task and the VDP have been found to be unacceptably low (Ataya et al., 2012a; Field & Christiansen, 2012; Schmukle, 2005) and results may be highly dependent on task design and decisions made by the researcher (Price et al., 2015). The use of more direct and sensitive measurements of attention, such as eye tracking, is therefore warranted. Patterns in eye fixations, fixation duration and latency, eye movements (saccades) and pupillary responses are seen as direct manifestations of attention (Henderson, 2003). Research using eye tracking has revealed that problematic drinkers direct their attention towards alcohol-related pictorial stimuli and maintain their gaze on these stimuli longer than light drinkers (Ceballos, Komogortsev, & Turner, 2009; Friese, Bargas-Avila, Hoffman, & Wiers, 2010; Miller & Fillmore, 2010; but see Hobson, Bruce, & Butler, 2013 for contrasting results).

In this paper, we expand on this research by including problematic drinkers with mild to borderline intellectual disability (MBID; IQ 50–85; American Psychiatric Association, 2013). Individuals with MBID are at risk for developing problematic alcohol use (Burgard, Donohue, Azrin, & Teichner, 2000; McGillicuddy, 2006) and are thought to experience more severe negative consequences from problematic alcohol use compared to

individuals without MBID (Slayter, 2008). Although this group has gained attention over the past years, screening and assessment tools and effective treatment interventions are scarce (Kerr, Lawrence, Darbyshire, Middleton, & Fitzsimmons, 2013) and little is known about the neuropsychological underpinnings of problematic alcohol use, such as the existence of attentional biases (Van Duijvenbode et al., 2015). This line of research would be interesting, because the existence of cognitive biases not only provides a theoretical framework for understanding the development and maintenance of problematic alcohol use, but also provides new ways to screen, assess and treat problematic alcohol use (see Stacy & Wiers, 2010). In a first study on this topic, we found no evidence of an attentional bias in problematic drinkers with and without MBID (Van Duijvenbode, Didden, Korzilius, & Engels, 2016b). Although full scale IQ did not influence the strength of the attentional bias, it did appear to influence task performance. In combination with the problematic psychometric qualities of the VDP, there therefore is a need to replicate these results using more direct measures such as eye tracking.

The aim of the present study was to compare the strength of the attentional bias between light and problematic drinkers with and without MBID. Our first hypothesis was that problematic drinkers would show an attentional bias towards alcohol-related pictures. To study this hypothesis, we analysed both eye tracking data and behavioural data (i.e., RT data) of the VDP. With regard to the eye tracking data, we hypothesised that problematic drinkers would be more likely than light drinkers to direct their attention towards pictures of alcoholic beverages and would look at these pictures longer than light drinkers. With regard to the behavioural data, we hypothesised that problematic drinkers would respond faster than light drinkers to probes replacing pictures of alcoholic beverages. Our second hypothesis was that the strength of the attentional bias would correlate positively with the severity of alcohol-related problems, meaning that problematic drinkers were expected to show a stronger attentional bias than light drinkers. Following the meta-analysis conducted by Field et al. (2009), we included the current level of craving as a covariate in our analyses.

Method

Participants

Participants were recruited from organisations within ID care (n = 42, 31.6%) and addiction medicine (n = 56, 42.1%) and via advertisements on social media, the Radboud University and word of mouth (n = 35, 26.3%). Participants younger than 18 years old, who were in an active psychotic or manic state, who were showing withdrawal symptoms or who had a history of problematic alcohol use but were currently abstaining for longer than 1.5 months were excluded from participating.

A total of 133 participants (94 men, 70.7%) with a mean age of 42.5 years (*SD* = 11.6, range = 18–65) took part in this study. The educational level of participants ranged between no completed education (*n* = 1, 0.8%) to a university (college) degree (*n* = 24, 18.0%). Most participants completed vocational school (*n* = 47, 35.3%) or special education (*n* = 42, 31.6%). The majority of the participants originated from the Netherlands (*n* = 122, 91.7%). All participants spoke Dutch fluently and had normal or corrected to normal vision. Roughly half of the participants (*n* = 70, 52.6%) were diagnosed with one or more psychiatric disorders, as assessed by the treatment team. In addition to substance use disorders (*n* = 57, 42.9%), mood disorders (*n* = 9, 6.8%), anxiety disorders (*n* = 7, 5.3%) and attention deficit hyperactivity disorder (*n* = 7, 5.3%) were diagnosed most often. Fifteen participants (11.3%) were diagnosed with a personality disorder. Fifty participants (37.6%) were prescribed psychotropic medication, including benzodiazepines, antipsychotics and antidepressants.

Apparatus and material

Attentional bias

The attentional bias was measured using the Visual Dot Probe task *(*VDP; MacLeod et al., 1986; for a detailed description of the task adapted to individuals with MBID, see Van Duijvenbode, Didden, Voogd, Korzilius, & Engels, 2012b). The task was identical to the one used in Van Duijvenbode et al. (2016b). It was presented on the Tobii T120 Eye Tracker (Tobii Technology, Danderyt, Sweden) – a corneal reflection eye tracker, used to record eye movements of both eyes of the participants at 60 Hz with an average accuracy of 0.5° visual angle. The VDP consisted of one practice block of 30 trials and four test blocks of two buffer trials and 25 critical trials (i.e., 100 critical trials). Neutral pictures were used for the practice and buffer trials. Critical trials consisted of two pictures of one alcoholic and one non-alcoholic beverage, presented side by side and matched for structural content (i.e., colour and size). After picture offset, a dot probe (white dot) appeared on either the left or the right side of the screen. Participants were instructed to indicate the position of the probe as quickly as possible by pressing a button on the response box.

Substance use

The Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q; VanDerNagel, Kiewik, Van Dijk, De Jong, & Didden, 2011b) was used to assess participants' substance use. Participants reported their general frequency and quantity of alcohol use, which was then converted into standard units of 10g of alcohol (International Center for Alcohol Policies, 2010). The severity of alcohol use-related problems was measured with the Alcohol Use Disorder Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Dutch translation: Schippers & Broekman, 2010). This is a standardised questionnaire of 10 questions about the amount, frequency and consequences of drinking alcohol. All questions were answered on a 5-point rating scale ranging from

'never' (0 points) to 'almost every day' (4 points). Total scores range between 0 and 40. A score of 8 or more indicates hazardous alcohol use (Babor et al., 2001) and was used in this study to classify participants as either light drinkers (score < 8) or problematic drinkers (score ≥ 8). In the current study, Cronbach's alpha was .91 (mean inter-item correlation = .49).

Craving

Craving was measured by a single-item, anchored visual analogue scale (VAS) in the shape of a thermometer ranging from 0 (*not at all*) to 10 (*extremely*). Participants were asked to assess their current level of craving for alcohol after conducting the VDP. To guide participants in this assessment, the VAS included a visual representation of level of craving by a gradual change of colour from green to red (see Hartley & MacLean, 2006).

IQ

If possible, the most recent scores on the Dutch version of the Wechsler Adults Intelligence Scale third edition (WAIS-III-NL; Uterwijk, 2000b) in the participants' files were used to measure IQ. If IQ was unknown, a short version of the WAIS-III was used (n = 86, 64.7%) to overcome time-related issues and possible problems with participant fatigue, agitation and frustration (Van Duijvenbode, Didden, Van den Hazel, & Engels, 2016a). The short form can be administered in approximately 30 minutes and consists of four subtests (Vocabulary, Similarities, Block design and Matrix reasoning). It provides a reliable and valid estimate of full scale IQ in individuals with MBID (Van Duijvenbode et al., 2016a), which was used to identify participants with MBID (IQ < 85) or without MBID (IQ ≥ 85).

Procedure

The recruitment and selection procedure is identical to Van Duijvenbode et al. (2016b). After providing written informed consent, participants provided general demographic information and information regarding their alcohol and other substance use. If necessary, the WAIS-III short form was administered to estimate full scale IQ. Participants were then seated 60 cm from the computer monitor. The gaze of each participant was calibrated using a 5-point calibration procedure, in which participants were instructed to accurately fixate on an expanding-contracting blue circle that appeared on a white background. After successful calibration, the VDP was started. Participants were asked to sit in a natural position, to remain seated throughout the task and to refrain from moving closer towards or further away from the computer screen until the entire task was completed. After finishing the VDP, participants rated their current level of craving on a single-item VAS. In between tasks, participants were allowed to take a break whenever necessary. Finally, participants were thanked for their time and received a gift worth €5 (US $6.50, GBP £3.70) for their participation.

The study was approved by the Ethical Committee of the Faculty of Social Sciences, Radboud University, Nijmegen, the Netherlands (ECG2012-1301-003).

Preparation of the data and statistical analysis

To test our hypotheses, both the eye tracking data and the behavioural data of the VDP were analysed. Due to technical problems of the T120 Eye Tracker, data of only 94 participants could be used for the analysis of the eye tracking data. Eye tracking data consisted of the direction and latency of the initial fixation and the total time participants fixated on pictures of alcoholic and non-alcoholic beverages during the task (dwell time). Fixations on either the alcohol or control picture were identified if the participant fixated on the fixation cross before picture onset and shifted his gaze to one of the pictures at least 100 ms after picture onset and before picture offset. If the gaze was directed at the position of one of the pictures before picture onset, this was only scored as a fixation if the participant focused on this spot for longer than 150 ms (Field & Cox, 2008). Dwell time was calculated by summing the duration of fixations on the pictures of alcoholic and non-alcoholic beverages separately. For all the dependent variables, a bias score was calculated manually by the first author to indicate the direction of attention allocation and the proportion of time fixated on pictures of alcoholic beverages relative to the time spent fixating on pictures of non-alcoholic beverages (Field, Mogg, & Bradley, 2004; Rose, Brown, Field, & Hogarth, 2013). Trials with missing data at least 3 *SD*s above the sample mean were excluded from analyses (Field et al., 2004). Missing data included saccadic shift, eye blinks and failures of the equipment to record data. Based on these criteria, no participants were excluded. The mean number of trials in which we identified one or more fixations per participant was 78.0 (*SD* = 26.8), out of a possible 100. The mean number of trials in which participants focused on pictures of alcoholic beverages was 64.1 (*SD* = 27.1) and the mean number of trials in which participants focused on pictures of non-alcoholic beverages was 61.4 (*SD* = 26.7).

The behavioural data of the VDP were gathered using RTs. Following the recommendations of Fazio (1990) and in line with previous research (e.g., Schoenmakers et al., 2010; Sharbanee, Stritzke, Wiers, & Macleod, 2013), median RTs of critical trials were used instead of mean RTs to minimise the influence of outliers. An attentional bias score was calculated by subtracting the RT of trials in which the dot probe replaced the alcoholic beverage from the RT of trials in which the dot probe replaced the non-alcoholic beverage ($RT_{sod} - RT_{alc}$). A positive score indicated an attentional bias towards alcohol (i.e., shorter RTs on trials in which the dot probe replaced the alcoholic beverage), while a negative score indicated a bias away from alcohol (Loeber et al., 2009b). Noteworthy is that the internal consistency of the attentional bias scores was poor (Cronbach's alpha = .30, mean inter-item correlation = .01).

All data were analysed using IBM SPSS Statistics (Version 20). A one-way ANOVA and chi-square analyses were conducted to compare demographic variables between groups.

The eye tracking and behavioural data of the VDP were analysed using a 2 x 2 mixed design ANOVA, with group (light vs. problematic drinkers) and picture type (alcoholic vs. non-alcoholic beverage) as the independent variables. These analyses were complemented with ANCOVAs, with craving and (estimated) full scale IQ as covariates. The relationship between bias scores, AUDIT score, weekly alcohol consumption, (estimated) full scale IQ and craving was further investigated using *t*-tests and Pearson product-moment correlation coefficient. A power analysis (with G*Power Version 3.1.92) showed that with the number of participants in the sample and the statistical tests used a power of .82 was achieved at a medium effect size ($f = .25$) and α of .05.

Results

Group characteristics

Participants were divided into four groups based on severity of alcohol use-related problems (AUDIT score) and (estimated) full scale IQ: light drinkers without MBID (AUDIT score < 8, IQ ≥ 85; $n = 27$), problematic drinkers without MBID (AUDIT score ≥ 8, IQ ≥ 85, $n = 33$), light drinkers with MBID (AUDIT score < 8, IQ < 85, $n = 40$), and problematic drinkers with MBID (AUDIT score ≥ 8, IQ < 85, $n = 33$). Group characteristics are shown in Table 1. Unsurprisingly, a one-way ANOVA with a post-hoc Tukey HSD test showed that light and problematic drinkers with MBID had a significantly lower (estimated) full scale, verbal and performance IQ than participants without MBID, irrespective of severity of alcohol use-related problems. Similarly, problematic drinkers had a significantly higher AUDIT score and consumed more standard units of alcohol per week than light drinkers, irrespective of IQ. Light and problematic drinkers also differed significantly on gender ratio ($\chi^2(3, N = 133) = 10.08$, $p = .018$), with more men ($n = 54$) than women ($n = 12$) in the problematic drinking groups. The groups did not differ on age, cultural background and level of craving ($ps > .05$).

Eye tracking data

To test the first hypothesis that problematic drinkers would show an attentional bias towards alcohol, eye tracking data of the VDP were analysed using a 2 x 2 mixed design ANOVA (see Table 2). The picture type x group interaction was not statistically significance for either of the dependent variables, meaning there was no bias in the initial orienting or maintenance of attention towards alcohol-related stimuli in problematic drinkers. These results maintained after controlling for (estimated) full scale IQ, gender and current level of craving ($ps > .05$) in an ANCOVA.

Mean bias scores were further analysed using a one-sample *t*-test to compare the strength of the bias to zero, indicating no bias. Both light and problematic drinkers showed an attentional bias in the direction of the initial fixation ($M = 4.80$, $SD = 7.91$, $t(50)$

Table 1 Participant Characteristics per Group (N = 133): Light Drinkers without Mild to Borderline Intellectual Disability (MBID; n = 27), Problematic Drinkers without MBID (n = 33), Light Drinkers with MBID (n = 40), and Problematic Drinkers with MBID (n = 33).

	Without MBID		**With MBID**				
	Light drinkers	Problematic drinkers	Light drinkers	Problematic drinkers			
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*F*(3,108)	*p*	η_p^2
Age	42.38 (13.19)	46.69 (8.16)	39.36 (12.95)	43.10 (10.42)	2.30	.081	.06
Est. full scale IQ	95.27 (6.84)	95.53 (7.58)	69.12 (8.54)	73.73 (8.18)	96.47	< .001	.71
Est. verbal IQ	91.69 (7.67)	95.88 (8.89)	67.61 (6.95)	74.57 (9.81)	80.73	< .001	.67
Est. performance IQ	99.15 (11.12)	95.25 (13.39)	74.36 (11.07)	73.37 (7.35)	45.15	< .001	.54
Level of craving	1.90 (2.66)	1.49 (2.70)	1.18 (2.36)	2.18 (2.63)	0.96	.414	.02
AUDIT score	4.73 (2.01)	22.38 (6.59)	3.42 (2.33)	23.43 (5.96)	159.33	< .001	.80
Weekly alcohol consumption	5.23 (5.06)	142.70 (102.63)	3.19 (4.23)	148.43 (82.14)	45.07	< .001	.54

Note. AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001); η_p^2 = partial eta squared.

= 4.34, $p < .001$; $M = 4.33$, $SD = 10.00$, $t(42) = 2.84$, $p = .007$; respectively) and dwell time ($M = 2727.69$; $SD = 6462.99$; $t(50) = 3.01$; $p = .004$; $M = 6169.00$; $SD = 12048.78$, $t(42) = 3.37$, $p = .002$; respectively), but not in the latency of the initial fixation ($M = 14.73$, $SD = 64.89$, $t(50) = 1.62$, $p = .111$; $M = -3.35$, $SD = 62.16$, $t(42) = -0.35$, $p = .726$; respectively). This means that both light and problematic drinkers were more likely to direct their attention towards pictures of alcoholic beverages and looked at these pictures longer than pictures of non-alcoholic beverages. Yet, an independent samples *t*-test indicated there were no significant differences in the strength of the biases in the direction and latency of the initial fixation and in dwell time between the two groups (*p*s > .05).

Behavioural data

To further explore the first hypothesis that problematic drinkers would show an attentional bias towards alcohol-related pictures, the behavioural data of the VDP (i.e., RT data) were also analysed. As shown in Table 2, a 2 x 2 mixed design ANOVA revealed that neither the main effect for picture type nor the picture type x group interaction reached statistical significance. These results maintained after controlling for (estimated) full scale IQ, gender and current level of craving in an ANCOVA ($F(1,127) = 0.75$, $p = .387$). A one-sample *t*-test confirmed that neither the attentional bias for light drinkers ($M = -1.26$, $SD = 29.23$, $t(66) = -0.35$, $p = .725$) nor for problematic drinkers ($M = 1.70$, $SD = 29.48$, $t(65) = 0.47$, $p = .642$) differed significantly from zero. There was also no significant difference in bias scores between the two groups ($t(131) = 0.58$, $p = .562$).

Correlational analyses

To test our second hypothesis that the strength of the attentional bias would correlate positively with the severity of alcohol-related problems, Pearson correlations were calculated between attentional bias scores (eye tracking and behavioural data), severity of alcohol use-related problems (AUDIT scores), weekly alcohol consumption, (estimated) full scale IQ and current level of craving. Weekly alcohol consumption correlated positively with the dwell time bias score ($r = .20$, $p = .049$) and craving correlated positively with the bias score for initial fixation latency ($r = .21$, $p = .047$), although both correlations were weak and marginally significant. Severity of alcohol use-related problems and (estimated) full scale IQ did not correlate with any of the attentional bias scores. In addition, the RT based bias score correlated significantly with the dwell time bias score ($r = .40$, $p < .001$), although not with bias scores for the direction ($r = .20$, $p = .054$) and latency ($r = .06$, $p = .560$) of the initial fixation.

Table 2 Descriptives and 2 x 2 Mixed-Design ANOVA Results with Group and Picture Type as Independent Variables.

	Non-alcoholic beverages		**Alcoholic beverages**				
	Light drinkers	Problematic drinkers	Light drinkers	Problematic drinkers			
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*F*(1,92)	*p*	η_p^2
Direction of initial fixation	34.12 (14.44)	39.77 (11.84)	38.92 (14.98)	44.09 (13.92)			
Picture type					24.41	< .001	.99
Picture type x Group					0.07	.796	.06
Latency of initial fixation	297.14 (119.98)	294.63 (131.96)	311.86 (132.01)	291.28 (124.24)			
Picture type					0.75	.390	.01
Picture type x Group					1.88	.174	.02
Dwell time	34055.14 (19291.42)	42264.00 (18584.61)	36782.82 (20422.933)	48460.00 (24473.03)			
Picture type					20.88	< .001	.19
Picture type x Group					3.15	.079	.03
Behavioural data (RT)	458.05 (111.30)	457.66 (115.48)	459.31 (105.53)	455.96 (105.32)			
Picture type					0.01	.932	.00
Picture type x Group					0.34	.562	.00

Note. η_p^2 = partial eta squared; RT = reaction time.

Discussion

Problematic drinkers have been shown to favour the processing of alcohol-related stimuli at the cost of other stimuli. Research suggests that these stimuli not only attract attention, but that problematic drinkers also find it difficult to disengage their attention from them. Together these results suggest an attentional bias towards alcohol-related stimuli in problematic drinkers (for reviews see Cox et al., 2006; Field & Cox, 2008; Robbins & Ehrman, 2004). The goal of the current study was to study this bias in problematic drinkers with and without MBID using both eye tracking methodology and behavioural data (i.e., RT data).

In contrast with our hypotheses, we found no evidence for an attentional bias in problematic drinkers, irrespective of (estimated) full scale IQ. As in our previous study in a comparable, clinical sample (Van Duijvenbode et al. (2016b)), we found a large standard deviation of the bias scores, especially of the behavioural data. This indicates that some problematic drinkers showed a bias *towards* alcohol-related pictures, while others showed a bias *away from* alcohol. Overall, however, problematic drinkers were not more likely than light drinkers to direct their attention towards pictures of alcoholic beverages, did not look at these pictures longer than light drinkers and did also not respond faster than light drinkers to probes replacing pictures of alcoholic beverages. We also found no correlation between the strength of the attentional bias, (estimated) full scale IQ and the severity of alcohol use-related problems. These results remained when controlling for current level of craving.

One explanation of our results may lie in the characteristics of the sample. For example, the majority of the problematic drinkers received treatment from organisations within addiction medicine at the time of the study. As a result, they might have learned new coping skills when confronted with alcohol-related stimuli (such as diverting their attention away from alcohol-related stimuli; Field & Cox, 2008). Indeed, several researchers – including ourselves (Van Duijvenbode et al., 2016b; Van Duijvenbode, Didden, Korzilius, & Engels, submitted) – have failed to find an attentional bias in problematic drinkers currently undergoing treatment (e.g., Noel et al., 2006; Townshend & Duka, 2007; Vollstädt-Klein et al., 2009). In addition, the large variability in strength of the attentional bias suggests that our participant group forms a heterogeneous group that can be divided into several subgroups (i.e., those who attend to and those who avoid alcohol-related stimuli). It remains unclear, however, what distinguishes these subgroups. Unexpectedly, current levels of craving were not associated with the strength of the (potential) attentional bias in the current study. Other variables that could influence the results include poly-substance use (Marks, Pike, Stoops, & Rush, 2015), co-morbid psychiatric disorders and the use of prescribed, psychotropic medication (Sinclair, Nausheen, Garner, & Baldwin, 2010). For example, Marks et al. (2015) have found that poly-substance use can decrease the strength of the attentional bias for substance-

related stimuli and Sinclair et al. (2010) found that co-morbid psychiatric disorders can influence the reaction time of participants, thereby influencing the results in an indirect way. Although we have this information, the diversity of the participants in, for example, combinations of used substances, type and degree of psychiatric co-morbidity and the type of medication described makes it difficult – if not impossible – to disentangle the precise mechanisms in which these factors influence the strength of the attentional bias. Future research on the influence of these factors on the strength of the cognitive biases and on specific co-morbid samples is therefore highly recommended.

A second explanation of our results lies in the problematic psychometric qualities of indirect tasks using reaction times, including the VDP. This has been noted previously (e.g., Ataya et al., 2012a; Field & Christiansen, 2012; Schmukle, 2005) and several suggestions have already been made to increase the stability of the task (Harrison & McCann, 2014; Miller & Fillmore, 2010; Price et al., 2015). It should be noted that even though eye tracking methodology is considered a more direct and sensitive way of measuring attention and the attentional bias (Field & Christiansen, 2012; Price et al., 2015), the reliability of this methodology has not been studied yet and could not be established using our data. In addition, it is possible to shift the attention without moving one's eyes. This has been called covert attention and is not captured using eye tracking methodology (Hunt & Kingstone, 2003; Posner, 1980). Researchers are therefore encouraged to continue the search for valid and reliable measures to capture the process of attention selection, orienting, maintenance and disengagement.

Our results have scientific and clinical implications. From a scientific point of view, our results fail to provide evidence for theories suggesting an attentional bias in problematic drinkers and a relationship between the strength of the bias, the severity of alcohol use-related problems and craving (e.g., Franken, 2003; Robinson & Berridge, 2003). Although measures such as those measuring the attentional bias could provide crucial information regarding the (neuropsychological) underpinnings of problematic alcohol use – and are therefore interesting from a scientific point of view – the results found in the present and previous studies call for scrutiny. Our results suggest that the strength of the attentional bias seems to vary in problematic drinkers. From a clinical point of view, and in line with other critical notions (e.g., Christiansen, Schoenmakers, & Field, 2015; Field, Marhe, & Franken, 2014; Marhe, Luijten, & Franken, 2014), we therefore conclude that measures of attentional biases for clinical purposes such as the screening, assessment and treatment of alcohol use disorders is, for now, discouraged.

INTERMEZZO

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Interpretation bias in problematic drinkers with mild to borderline intellectual disability

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Abstract

Problematic alcohol use is characterised by disrupted associative processing of environmental clues, where problematic drinkers interpret ambiguous, alcohol-relevant clues in an alcohol-related way. The present study examined the strength of this interpretation bias in a large sample ($N = 230$) of light and problematic drinkers with and without mild to borderline intellectual disability (MBID, IQ 50–85). All participants were asked to finish 24 open-ended, ambiguous scenarios with their first, spontaneous response. Consistent with the hypothesis, problematic drinkers with and without MBID were found to have an interpretation bias towards alcohol. The difference in the strength of the bias between light and problematic drinkers was strongest for negative scenarios. Participants with MBID showed a stronger interpretation bias compared to participants without MBID, especially on the negative scenarios. Problematic drinkers tend to interpret ambiguous, alcohol-relevant clues in an alcohol-related way and this tendency increases with higher levels of alcohol use-related problems. These results extend our knowledge on substance use disorder and provide new lines of inquiry for the assessment and treatment of problematic alcohol use in individuals with MBID.

Introduction

Environmental stimuli often require interpretation, explanation and evaluation. For example, when hearing the word "joint" you can think of the human anatomy, a place at which two or more things are joined or a marijuana cigarette. Your first association with a given (ambiguous) word depends on the context and your personal experiences and memories. That is, this type of associative processing is founded on memory, which acts as an associative network (Bechara, Noel, & Crone, 2006; Strack & Deutsch, 2004; Wiers et al., 2007). The ease with which a cluster of associations is activated depends on the accessibility of that cluster or the strength between the elements and occurs fast, unintentionally and outside one's control or awareness. Through a process of classical conditioning, experiences shape the associative network by forming clusters which can activate motivational tendencies and subsequently influence behaviour by responding consistent with those tendencies (Collins & Loftus, 1975).

Although associative processing is not problematic in itself, its influence on behaviour can become problematic, for example in substance use disorders (SUD). As examining these processes might improve our understanding of SUD and its treatment options, several attempts have been made to measure automatic associations and interpretations. Typically, automatic associations and interpretations have been assessed using direct measures (e.g., questionnaires and rating scales) and indirect measures. Indirect measures are thought to tap into implicit cognitive processes, are considered to measure less accessible memory associations than those assessed by self-report and are thought to reduce self-presentation influences or social desirability because they do not directly mention the targeted behaviour (Greenwald et al., 2002; Stacy & Wiers, 2010). Examples of indirect measures include the implicit association task (Greenwald, McGhee, & Schwartz, 1998) and word association tasks, in which individuals are asked to generate their first, spontaneous response when hearing an ambiguous word, sentence or scenario. Despite the control participants can assert over their responses in word association tasks, their responses probably relate more to implicit associations and interpretations because of the stronger focus on first, 'gut' responses compared to traditional self-report measures (Ranganath, Smith, & Nosek, 2008). Word association tasks have been found to be the strongest predictors of alcohol use in comparison with other indirect measures (Thush et al., 2007; Van der Vorst et al., 2013).

Using word association tasks, an interpretation bias has been found in problematic drinkers. In other words, problematic drinkers have been found to interpret ambiguous, alcohol-relevant words, phrases or scenarios in an alcohol-related way (Ames, Sussman, Dent, & Stacy, 2005; Krank, Schoenfeld, & Frigon, 2010; Salemink & Wiers, 2014; Woud, Fitzgerald, Wiers, Rinck, & Becker, 2012; Woud et al., 2014). For example, Krank et al. (2010) found that problematic drinkers associated words such as "pitcher" or "draft" in an alcohol-related manner more often compared to light drinkers. Woud et al. (2012) found

similar results using short scenarios – an approach that increases the ecological validity of the task and allows for individual differences in the underlying associative network. Using this approach, Salemink and Wiers (2014) and Woud, Becker, Rinck and Salemink (2015a) found that problematic drinkers associate both positive (e.g., a party, being out with friends) and negative scenarios (e.g., feeling down or stressed) with alcohol use. In addition, similar correlations between the strength of the biases for positive and negative scenarios and the severity of alcohol use-related problems have been reported by these authors.

In this study, we expand on these findings by including problematic drinkers with mild to borderline intellectual disability (MBID; IQ 50–85, American Psychiatric Association, 2013). They are at risk for developing problematic alcohol use and alcohol use disorders (Burgard, Donohue, Azrin, & Teichner, 2000; McGillicuddy, 2006) and often experience more severe negative consequences from alcohol use compared to individuals without MBID (Slayter, 2008). Although this group has gained attention over the past years, the current knowledge on SU(D) in individuals with MBID is scarce and there is a need for valid screening and assessment tools and effective treatment interventions (Kerr, Lawrence, Darbyshire, Middleton, & Fitzsimmons, 2013; Van Duijvenbode et al., 2015). From a scientific point of view, studying the interpretation bias would thus extend our knowledge on the role of this bias in SUD in individuals with MBID and shed light on the role of cognitive functioning on the interpretation bias. From a clinical point of view, studying the interpretation bias would provide new ways for the assessment and treatment of problematic alcohol use in individuals with MBID. For example, as word association tasks provide indirect measures of high-risk situations for alcohol use or relapse (Woud et al., 2012), these tasks could provide possibilities for tailoring treatment to the needs and characteristics of the individual and provide implications for treatment and relapse prevention, for example by focusing treatment more specifically on personal high-risk situations that are associated with alcohol use and directly changing the alcohol associations in an interpretation retraining procedure (Woud et al., 2012). Preliminary evidence shows that the alcohol-related interpretation bias can indeed be trained in such interpretation retraining procedures (Woud, Hutschemaekers, Rinck, & Becker, 2015b).

The aim of our study was twofold. First, we aimed to compare the strength of the interpretation bias between light and problematic drinkers. In line with earlier results on the interpretation bias in problematic drinkers (for an overview, see Stacy & Wiers, 2010), our first hypothesis was that problematic drinkers with and without MBID would show an interpretation bias towards alcohol and that this bias would be significantly stronger in problematic drinkers compared to light drinkers. Second, we wanted to explore the dynamics of the interpretation bias in more detail by calculating a bias score for positive and negative scenarios separately. In line with Salemink and Wiers (2014) and Woud et al. (2015a) we expected that problematic drinkers would show an interpretation bias on both the positive and the negative scenarios, and that both bias scores would be equally strong correlated with the severity of alcohol use-related problems. As this is the first

study on the interpretation bias in problematic drinkers with MBID, we did not formulate any a priori hypotheses regarding the role of intellectual functioning on the strength or manifestation of the interpretation bias but ran exploratory analyses instead.

Method

Participants

This sample is a combination of the sample of two of our other studies (Van Duijvenbode, Didden, Korzilius, & Engels, 2016b; Van Duijvenbode, Didden, Korzilius, & Engels, submitted). Participants were recruited from organisations within ID care (n = 109, 47.%) or addiction medicine (n = 30, 13.0%), via advertisements on social media, the Radboud University and word of mouth (n = 91, 39.6%). Inclusion criteria were an age of 18 years or older, an IQ of minimally 50 and stable functioning (i.e., no active psychotic or manic state, as assessed by the treatment team). All participants were required to have had access to and/or consumed alcohol in the last 1.5 months. Those with a history of problematic alcohol use but currently abstaining for longer than 1.5 months were excluded from participating.

We included 230 participants (139 men, 60.4%) with a mean age of 32.3 years (SD = 12.5, range = 18–61 years). Highest completed form of education ranged between none (4.3%, n = 10) to university (13.0%, n = 30). Most participants finished special education (24.3%, n = 56) or secondary school (24.3%, n = 56). The majority of participants originated from The Netherlands (92.2%, n = 212). The other participants originated from Surinam/The Antilles (2.1%, n = 5), Morocco/Turkey (1.6%, n = 4) or other Western and non-Western countries (3.9%, n = 9). All participants spoke Dutch fluently and had no trouble understanding the instructions. Almost half of the participants (46.1%, n = 106) were diagnosed with one or more psychiatric disorders, of which substance use disorder (28.3%, n = 65), autism spectrum disorder (11.7%, n = 27) and attention deficit hyperactivity disorder (7.0%, n = 16) were diagnosed most often. Seventy-five participants (32.6%) used psychotropic medication, including antipsychotics and antidepressants.

A power analysis (with G*Power Version 3.1.92) showed that with the number of participants in the sample and the statistical tests used a power of .97 was achieved at a medium effect size of .3 and α of .05.

Material

Substance use

The Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q; VanDerNagel, Kiewik, Van Dijk, De Jong, & Didden, 2011b) was used to assess participants' alcohol use. This is an interview method adapted to the needs of those with MBID, for example by avoiding lengthy phrases and difficult wording (VanDerNagel, Kemna, &

Didden, 2013). Participants reported their general frequency and quantity of alcohol use, which was converted into standard units of 10g of alcohol (International Center for Alcohol Polities, 2010).

The severity of alcohol use-related problems was measured using the Alcohol Use Disorders Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Dutch translation: Schippers & Broekman, 2010). This questionnaire consists of ten questions about the frequency, quantity and consequences of alcohol use which are answered on a 5-point rating scale ranging from 'never' (0 points) to 'almost every day' (4 points). Total scores range between 0 and 40, with higher scores reflecting more severe alcohol use-related problems. A score of 8 or more is indicative of hazardous alcohol use (Babor et al., 2001) and was used in this study to classify participants as either light drinkers (score < 8) or problematic drinkers (score ≥ 8). The internal consistency of the AUDIT in the current study was good (Cronbach's alpha = .88, mean inter-item correlation = .42).

Interpretation bias

The interpretation bias was measured with the open-ended, ambiguous scenarios developed by Woud et al. (2012). This task consists of 24 situations (8 positive, 6 negative and 10 neutral) that each allow for different interpretations (see Table 1). The positive and negative scenarios are based on the Inventory of Drinking Situations (Annis, 1982) and tap into situations associated with alcohol use. The scenarios were adapted to ensure feasibility in an older (clinical) sample and for individuals with MBID.

Each scenario consisted of a title and three lines. The last sentence ended abruptly and participants were asked to finish each scenario with their first, spontaneous response. All participants were ensured there were no correct or incorrect answers and they should respond with whatever came up in their mind first. There was no time limit for the administration of the task. Taking into account that participants with MBID often have reading and writing difficulties, all scenarios were read out loud. The answers provided by the participants were written down verbatim by the researcher. To control for carry-over effects, we used three different booklets with a different order of scenarios. The order of the booklets was counterbalanced across participants[1].

All answers provided by participants were coded individually by the first author and a trained student in a conservative and liberal way (Frigon & Krank, 2009; Woud et al., 2012). Only the conservative approach will be reported in this article (cf. Woud et al., 2014). All responses were coded as binary variables in this approach: '1' for alcohol-related answers and '0' for ambiguous or alcohol-unrelated answers. Consensus scores agreed upon by both raters were used to calculate mean bias scores (i.e., total score, positive scenario score, negative scenario score) for each participant. Total bias scores ranged between 0 and 24, while the bias scores for positive and negative scenarios had a maximum of 8 and 6 respectively. Alcohol-related answers on neutral scenarios were only included in the total bias score, but not calculated separately. Inter-rater reliabilities for the

total bias score (Cohen's kappa = .99, $p < .001$, percentage of agreement: 99.8%) and the bias scores for positive scenarios (Cohen's kappa = .98, $p < .001$, percentage of agreement: 99.3%) and for negative scenarios (Cohen's kappa = .99, $p < .001$, percentage of agreement: 99.9%) separately were excellent.

Table 1 Examples of the Positive, Negative and Neutral Scenarios used (Woud et al., 2012) and Possible Answers given by Participants.

	Scenario	**Possible answers**
Positive scenario	**Movie night** Movie night at your friends house. "One more?", one of your friends asks. You cannot resist temptation and reach for a …	New film (alcohol-unrelated) Glass (ambiguous) Beer (alcohol-related)
Negative scenario	**Bad day** It is a horrible day and nothing works. You want to lose this bad feeling and treat yourself. You get a strong craving for …	Chocolate (alcohol-unrelated) A drink (ambiguous) Alcohol (alcohol-related)
Neutral scenario	**Poker** You play poker with your friends every other week. Everything is ready and the cards have been dealt. This time, your cards are very …	Good (alcohol-unrelated) Bad (alcohol-unrelated) Difficult to win with (alcohol-unrelated)

IQ

IQ was measured using the most recent scores on the Dutch version of the Wechsler Adults Intelligence Scale third edition (WAIS-III-NL; Uterwijk, 2000b) in the participants' files. If IQ was unknown, we administered a short version of the WAIS-III (47.8%, $n = 110$) to overcome time constrains and possible problems with participant fatigue, agitation and frustration (Van Duijvenbode, Didden, Van den Hazel, & Engels, 2016a). The WAIS-III short form is based on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) and can be administered in approximately 30 minutes. It consists of four subtests (Vocabulary, Similarities, Block Design and Matrix Reasoning) and provides a valid and reliable estimate of full scale IQ (Van Duijvenbode et al., 2016a). Full scale IQ was used to identify participants with MBID (IQ < 85) and without MBID (IQ ≥ 85).

Procedure

All participants were provided with written information about the study before signing informed consent forms. The session started with questions regarding general demographic information and, if necessary, the WAIS-III short form to estimate full scale IQ. The scenario task was then used to measure the interpretation bias, after which the SumID-Q was

administered to assess general patterns of alcohol use and the severity of alcohol use-related problems. As this study is part of a larger PhD project on the neuropsychology of SUD in individuals with MBID, all participants also completed other computerised tasks to measure cognitive biases (i.e., visual dot probe task, approach avoidance task; Van Duijvenbode et al., 2016b) and executive control (i.e., Corsi block tapping task, Go/No-go task; Van Duijvenbode et al., submitted). These tasks were administered after completion of the word association task. In between tasks, participants were allowed to take a break whenever necessary. Finally, participants were thanked for their time and received a gift worth €5 (US $6.50, GBP £3.70) for their participation. The study was approved by the Ethical Committee of the Faculty of Social Science, Radboud University, Nijmegen, the Netherlands (ECG2012-1301-003).

Results

Group characteristics

Participants were divided into four groups based on the severity of alcohol use-related problems and (estimated) full scale IQ: light drinking participants without MBID (n = 57), problematic drinking participants without MBID (n = 55), light drinking participants with MBID (n = 50) and problematic drinking participants with MBID (n = 68). There were no missing data on any of the key variables. As expected, a one-way between groups ANOVA with post-hoc Tukey HSD comparisons showed that participants with MBID had a significantly lower (estimated) full scale, verbal and performance IQ compared to participants without MBID. Similarly, problematic drinkers had a significantly higher AUDIT score and weekly alcohol consumption compared to light drinkers (see Table 2). Groups also differed in gender ratio ($\chi^2(3, N = 230) = 42.56$, $p < .001$), with larger proportions of light drinking (n = 60, 26.1%) compared to problematic drinking women (n = 31, 13.5%)[1].

Interpretation bias

To test our first hypothesis that problematic drinkers would show an interpretation bias towards alcohol, we first calculated Pearson product-moment correlation coefficients. There was a strong, positive correlation between the severity of alcohol use-related problems (AUDIT score) and total bias score (r = .63, $p < .001$). Second, we conducted one-sample t-tests to compare the mean total bias scores to zero, meaning no bias. The total bias scores of both light (M = 2.08, SD = 1.80, 95% confidence interval (CI): 1.74–2.43) and problematic drinkers (M = 4.55, SD = 2.72, 95% CI: 4.07–5.04) differed significantly from zero, $t(106) = 11.96$, $p < .001$; $t(122) = 18.50$, $p < .001$, respectively. In addition, an independent samples t-test was conducted to compare the strength of the interpretation bias between light and problematic drinkers. There was a significant difference in total bias scores between light drinkers and problematic drinkers, $t(228) = 7.97$, $p < .001$, Cohen's d = 0.94.

Table 2 Participant Characteristics per Group (N = 230): Light Drinkers without Mild to Borderline Intellectual Disability (MBID; n = 57), Problematic Drinkers without MBID (n = 55), Light Drinkers with MBID (n = 50), and Problematic Drinkers with MBID (n = 68).

	Without MBID		With MBID		*F* (3,226)	*p*	η_p^2
	Light drinkers	Problematic drinkers	Light drinkers	Problematic drinkers			
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*			
Age	29.07 (12.06)	31.47 (12.00)	33.22 (11.90)	34.82 (13.12)	2.42	.067	.03
Est. full scale IQ	105.42 (11.09)	103.49 (11.36)	70.52 (8.53)	68.73 (8.60)	229.54	< .001	.76
Est. verbal IQ	102.21 (11.10)	102.02 (12.91)	71.00 (10.19)	69.78 (9.93)	149.62	< .001	.68
Est. performance IQ	107.56 (12.62)	105.46 (12.77)	73.09 (10.63)	88.77 (21.07)	171.64	< .001	.71
AUDIT score	4.23 (2.13)	16.05 (6.62)	3.24 (2.21)	17.34 (6.81)	123.05	< .001	.62
Weekly alcohol consumption	3.35 (4.10)	48.09 (74.65)	1.94 (3.16)	61.99 (97.82)	13.35	< .001	.15

Note. AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001); η_p^2 = partial eta squared.

Positive and negative scenarios

To test our second hypothesis that the strength of the interpretation bias between light and problematic drinkers would be similar for positive and negative scenarios, we first calculated Pearson product-moment correlation coefficients. There were medium to strong correlations between the severity of alcohol use-related problems (AUDIT score) and the positive (r = .42, p < .001) and negative bias scores (r = .63, p < .001). A Fisher r-to-z-transformation indicated that the bias score for negative scenarios correlated significantly stronger with the severity of alcohol use-related problems than the bias score for positive scenarios (z difference = -3.13, p < .001).

These results were complemented with an independent samples t-test to compare the strength of the bias scores for light and problematic drinkers. Results showed that problematic drinkers scored significantly higher than light drinkers on the positive scenarios (M = 2.39, SD = 1.37, 95% CI: 2.15–2.63; M = 1.39, SD = 1.19, 95% CI: 1.16 – 1.62 respectively; t(228) = 5.87, p < .001, Cohen's d = 0.78) and the negative scenarios (M = 2.10, SD = 1.82, 95% CI: 1.77–2.42; M = 0.65, SD = 0.94, 95% CI: 0.47–0.83 respectively; t(228) = 7.40, p < .001, Cohen's d = 0.98). Last, a linear regression analysis was conducted to assess the ability of the bias scores for positive and negative scenarios to predict the severity of alcohol use-related problems (AUDIT score). The full model was statistically significant (F(2,227) = 81.52, p < .001) and explained 64.7% of the variance. Both the bias score for positive scenarios (β = 0.96, SE = .35, p = .006) and the bias score for negative scenarios (β = 2.81, SE = .29, p < .001) significantly predicted the severity of alcohol use-related problems.

Role of IQ

Last, to investigate the role of IQ in the interpretation bias, we first calculated Pearson product-moment correlation coefficients. Estimated full scale IQ correlated negatively with the total bias score (r = -.22, p < .001) and the bias score for negative situations (r = -.28, p < .001), but not with the bias score for positive scenarios (r = -.07, p = .291).

These results were supplemented with linear regression analyses to assess the predictive validity of the severity of alcohol use-related problems and (estimated) full scale IQ for total, positive and negative bias scores. When predicting the total bias score, the full model was statistically significant (F(2,219) = 76.95, p < .001) and explained 64.2% of the variance. Both AUDIT score (β = .20, SE = .02, p < .001) and estimated full scale IQ (β = -.02, SE = .01, p = .017) predicted the total bias score significantly. Similar results were found when predicting the bias score for negative scenarios. This model was also statistically significant (F(2,219) = 82.40, p < .001) and explained 65.5% of the variance. AUDIT score (β = .12, SE = .01, p < .001) and estimated full scale IQ (β = -.02, SE = .01, p < .001) both predicted the strength of the bias score for negative scenarios significantly. Last, when predicting the bias score for positive scenarios, the full model was statistically significant (F(2,219) = 25.58, p < .001) and explained 43.5% of the variance. Unlike the other

Table 3 Descriptives and Two-Way Between-Groups ANOVA Results per Participant Group (N = 230): Light Drinkers without Mild to Borderline Intellectual Disability IQ (n = 57), Problematic Drinkers without MBID (n = 55), Light Drinkers with MBID (n = 50), and Problematic Drinkers with MBID (n = 68).

	Without MBID			**With MBID**			*F* (1,226)	*p*	η_p^2
	Light drinkers	Problematic drinkers	Total group	Light drinkers	Problematic drinkers	Total group			
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*			
Total score	1.65 (1.37)	4.33 (2.47)	2.96 (2.39)	2.58 (2.10)	4.74 (2.93)	3.82 (2.81)			
Alcohol use							61.22	<.001	.21
IQ							4.70	.031	.02
Alcohol use x IQ							0.72	.398	.00
Positive scenarios	1.23 (1.05)	2.55 (1.33)	1.88 (1.36)	1.58 (1.31)	2.26 (1.39)	1.97 (1.39)			
Alcohol use							34.66	<.001	.13
IQ							0.04	.834	.00
Alcohol use x IQ							3.46	.064	.02
Negative scenarios	0.39 (0.65)	1.76 (1.72)	1.06 (1.46)	0.96 (1.12)	2.37 (1.86)	1.77 (1.73)			
Alcohol use							52.17	<.001	.19
IQ							9.33	.003	.04
Alcohol use x IQ							0.01	.938	.00

Note. η_p^2 = partial eta squared.

two models, AUDIT score was the only significant predictor ($\beta = .08$, $SE = .01$, $p < .001$). Estimated full scale IQ did not significantly predict the strength of the bias score for positive scenarios ($\beta = .00$, $SE = .01$, $p < .925$).

Last, a 2 x 2 between-groups ANOVA was conducted. Participants were divided into four groups according to their estimated full scale IQ and severity of alcohol use related problems based on the AUDIT score (i.e., light and problematic drinking participants with and without MBID). The *p*-level of the interaction effect between IQ and severity of alcohol use-related problems did not reach statistical significance in any of the analyses (see Table 3). There were significant main effects of severity of alcohol use-related problems, both when analysing total bias scores and when analysing bias scores for positive and negative scenarios separately. Problematic drinkers were shown to have stronger bias scores (total: $M = 4.55$, $SD = 2.73$; positive scenarios: $M = 2.39$, $SD = 1.37$; negative scenarios: $M = 2.10$, $SD = 1.82$) than light drinkers (total: $M = 2.08$, $SD = 2.73$; positive scenarios: $M = 1.39$, $SD = 1.19$; negative scenarios: $M = 0.65$, $SD = 0.94$). In addition, there were significant main effects for full scale IQ on the total bias score and the bias score for negative scenarios, with higher total scores and bias scores on negative scenarios for participants with MBID compared to participants without MBID. When controlling for estimated verbal IQ in a partial correlation analysis and an ANCOVA, all these results remained.

Discussion

Research has repeatedly shown that problematic drinkers tend to interpret ambiguous, alcohol-relevant words, sentences or scenarios in an alcohol-related way, consistent with an interpretation bias. In the current study, we expanded on these findings by including problematic drinkers with mild to borderline intellectual disability (MBID).

In line with previous research (Ames et al., 2005; Krank et al., 2010; Salemink & Wiers, 2014; Woud et al., 2012, 2014) we found problematic drinkers with and without MBID to have an interpretation bias towards alcohol. In addition, this bias was significantly stronger in problematic drinkers compared to light drinkers and correlated positively with the severity of alcohol use-related problems. Hence, the strength of the interpretation bias increases with higher levels of alcohol use-related problems. When exploring the dynamics of the interpretation bias in more detail, we found the differences in the strength of the bias between light and problematic drinkers to be strongest for the negative scenarios. The bias score for negative scenarios made a substantially bigger contribution to the prediction of the severity of alcohol use-related problems than the bias score for positive scenarios. Although speculative, these results appear in line with literature on drinking motives, which has shown that problematic drinkers – both with MBID (Didden, Embregts, Van der Toorn, & Laarhoven, 2009; Taggart, McLaughlin, Quinn,

& McFarlane, 2007) and without MBID (Kuntsche et al., 2014; Mezquita et al., 2011) – frequently drink alcohol to cope with stress and other negative emotions. But note that enhancement motives have also frequently been found to be related to problematic drinking (Cadigan, Martens, & Hermans, 2015). Coping drinkers might have formed an association between experiencing unpleasant emotions and tension reduction by repeatedly drinking alcohol in response to negative scenarios or situations. These situations can then trigger the activation of alcohol-related associations. Indeed, Salemink and Wiers (2014) and Woud et al. (2015a) showed that social/enhancement drinking motives predict the strength of the interpretation bias for positive situations, whereas coping drinking motives predicted the strength of bias score for negative situations.

Although we did not hypothesise a specific role of full scale IQ on the strength of the interpretation bias, we found the total bias score and the bias score for negative scenarios of light and problematic drinkers to be higher among individuals with MBID compared to individuals without MBID. Similarly, the strength of the bias score correlated negatively with estimated full scale IQ. These results remained when controlling for estimated verbal IQ, suggesting that vocabulary and verbal reasoning do not play a role in the assessment of the interpretation bias. One explanation for the stronger interpretation bias in individuals with MBID is that participants were aware they were participating in a research study on substance use, which could have activated the cluster of associations related to this topic. As individuals with MBID are often more vulnerable to probing questions and are more likely to please others, this could have resulted in them responding in accordance with the research goals more often than individuals without MBID (Finlay & Lyons, 2001, 2002).

From a clinical perspective, these results imply that the scenario-based approach provides a new method to assess the severity of alcohol use-related problems. For example, this method might provide a less biased way of assessing high-risk situations for alcohol use or relapse compared to typical questionnaires (Ranganath et al., 2008; Woud et al., 2012) and could therefore be incorporated into prevention programmes. Measuring the interpretation bias also provides new ways to treat substance use disorder (SUD). That is, treatment interventions could focus on directly changing the interpretation bias by training problematic drinkers to interpret ambiguous alcohol-related cues in a neutral manner (cf. Kelly, Masterman, & Marlatt, 2005). Such treatment procedures have been shown to be promising in the field of anxiety (Amir & Taylor, 2012; Salemink, Van den Hout, & Kindt, 2009) and the feasibility has recently been generalised to the treatment of SUD (Woud et al., 2015b). It should be noted, however, that cognitive bias modification procedures have also been criticised, both in the field of anxiety and depression (Hallion & Ruscio, 2011; Mogoase, David, & Koster, 2014) as well as in the field of SUD (Christiansen, Schoenmakers, & Field, 2015; Field, Marhe, & Franken, 2013).

This study has several limitations that lead to suggestions for future research. First, participants were aware they were participating in a study on alcohol use. This could have

biased their response, for example by censoring their responses in line or in contrast with the research goals. Although the awareness score did not correlate with the interpretation bias score in a study by Woud et al. (2012), future research needs to take this into account as this could explain the stronger interpretation bias found in individuals with MBID. Second, a cross-sectional approach was used, which does not allow us to study causality in the relationship between the interpretation bias and drinking behaviour. In future studies, a prospective design should be adopted to investigate the predictive validity of the interpretation bias on alcohol consumption (and vice versa). This would increase our knowledge of the role the interpretation bias plays in the development and maintenance of SUD. Third, we specifically studied the interpretation bias in problematic drinkers. To be able to draw conclusions about the role of the interpretation bias in the aetiology of SUD in individuals with and without MBID in general, future research should focus on generalising these results to other substances and studying individual differences in the strength of the interpretation bias in more detail. For example, the role of executive control (e.g., inhibitory control, working memory; Burton, Pedersen, & McCarthy, 2012; Van Hemel-Ruiter, Wiers, Brook, & De Jong, in perss; Peeters et al., 2012;), craving (Field, Munafo, & Franken, 2009), poly substance use (Marks, Pike, Stoops, & Rush, 2015) and co-morbid psychiatric disorders (Sinclair, Nausheen, Garner, & Baldwin, 2010) have been studied in relation to other cognitive biases in problematic drinkers, but have not yet been explored in relation to the interpretation bias and could therefore be examined in future studies.

To conclude, our results show an interpretation bias towards alcohol in problematic drinkers both with and without MBID. Problematic drinkers with and without MBID tend to interpret ambiguous, alcohol-relevant scenarios in an alcohol-related way and this tendency increases with higher levels of alcohol use-related problems. The differences between light and problematic drinkers are largest in negative scenarios. Participants with MBID showed a stronger interpretation bias compared to participants without MBID, especially on the negative scenarios. These results add to the knowledge base on the underlying mechanisms of SUD and provide new lines of inquiry for the identification, assessment and treatment of SUD in clinical samples.

Footnotes

[1] We controlled for booklet number and gender in all analyses, but they had no effect. Therefore, only the results without booklet number and gender as controlling variables are reported.

8

Drinking motives and interpretation bias in problematic drinkers with mild to borderline intellectual disability

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Van Duijvenbode, N., Didden, R., VanDerNagel, J. E. L., Korzilius, H. P. L. M., & Engels, R. C. M. E. (resubmitted). *The relationship between drinking motives and interpretation bias in problematic drinkers with mild to borderline intellectual disability.*

Abstract

The goal of this study was to examine the relationship between drinking motives and the interpretation bias (interpreting ambiguous stimuli in an alcohol-related way) in problematic drinkers with and without mild to borderline intellectual disability (MBID). Participants (N = 178) were divided into four groups based on severity of alcohol use-related problems and full scale IQ. They completed a word association task and the Drinking Motives Questionnaire Revised (DMQ-R). Problematic drinkers showed an interpretation bias towards alcohol. Participants with MBID had a relatively strong interpretation bias. The DMQ-R coping motive predicted the strength of the bias in negative scenarios, whereas the DMQ-R coping and social motives predicted the strength of the bias in positive scenarios. The activation of this bias might depend on individual differences in drinking motives, which provides implications for the assessment and treatment of problematic alcohol use in individuals with and without MBID.

Introduction

Problematic alcohol use and alcohol use disorders are highly prevalent among the adult population. National data from the United States and studies among European countries indicate that around 6–12% of the adult population can be diagnosed with an alcohol use disorder (Merikangas & McClair, 2012; Rehm, Room, Van den Brink, & Jacobi, 2005). According to the American Psychiatric Association (APA, 2013), problematic alcohol use is characterised by the persistent desire to drink alcohol and the inability to cut down or control drinking, despite the adverse physical, psychological, social and interpersonal problems related to alcohol use. As Wiers and Stacy (2006, p. 292) note "[…] the typical problem in addiction is not that drug abusers do not realise that the disadvantages of continued drug use outweigh the advantages. The central paradox in addictive behaviours is that people continue to use substances even though they know the harm". Research has shown that this "paradox of addiction" can be explained by disruptions in the information processing and reward centre of the brain (Koob, 2013; Volkow, Wang, Tomasi, & Baler, 2013). For example, problematic drinkers have repeatedly demonstrated a pattern of selective information processing, including biases in association and interpretation (Stacy & Wiers, 2010).

The interpretation or association bias can be described as a tendency to interpret ambiguous cues in an alcohol-related way. That is, ambiguous cues often require interpretation, explanation and evaluation. The word "draft", for example, could refer to a current of air, a preliminary version of something you wrote or an alcoholic beverage drawn from a keg – depending on context and personal experience and memories (Van Duijvenbode, Didden, Korzilius, & Engels, in press). This bias is typically studied using indirect tasks, such as the implicit association task and word association tasks (for an overview, see Reich, Below, & Goldman, 2010; Stacy, Ames, & Grenard, 2006). In the present study, the focus is on the latter, because word association tasks have been found to be the strongest predictors of alcohol use compared to other indirect measures (Rooke, Hine, & Thorsteinsson, 2008; Thush et al., 2007). Word association tasks require participants to generate their first, spontaneous response to ambiguous cues, such as words (e.g., "pitcher", "draft") or scenarios (e.g., "out with friends on a Friday night"). Using these tasks, problematic drinkers have consistently been found to interpret these cues in an alcohol-related way (e.g., Ames, Sussman, Dent, & Stacy, 2005; Krank, Schoenfeld, & Frigon, 2010; Woud, Fitzgerald, Wiers, Rinck, & Becker, 2012; Woud et al., 2014), which is indicative of an interpretation bias towards alcohol.

It seems plausible that the tendency to interpret environmental or situational cues in an alcohol-related way is not *always* present, but instead may be triggered by internal (e.g., mood, motives) and external (e.g., places, persons) contextual cues. For example, while the word "draft" could be interpreted in an alcohol-related way, this interpretation might be more readily available when you're out with friends on a Friday night than when

you're working on a school assignment on Monday morning and you have just finished your first complete version. Similarly, certain thoughts, feelings, emotions or personal motives might also trigger alcohol-related associations and interpretations. Indeed, Krank and Wall (2006) theorise that the context may be an integral part of memory processing and thus be part of the individual's alcohol-related memories and associations. Following this line of reasoning, two recent studies have focused on the relationship between the interpretation bias and drinking motives (Salemink & Wiers, 2014; Woud, Becker, Rinck, & Salemink, 2015a). It was found that the level of coping drinking (i.e., drinking alcohol to cope with unpleasant emotions) predicted the strength of the interpretation bias in negative, stressful scenarios (e.g., feeling down or stressed). That is, by repeatedly drinking alcohol in response to negative situations, coping drinkers have formed an association between unpleasant emotions, alcohol use and tension reduction ("When I feel down or stressed, I can drink alcohol to feel better again"). Thus, their alcohol-related memory schemata become activated when confronted with negative situations, leading to an interpretation bias. Similarly, Salemink and Wiers (2014) – but not Woud et al. (2015a) – found that enhancement drinkers (i.e., individuals who drink alcohol to enhance positive emotions) showed an interpretation bias in positive, enjoyable scenarios (i.e., a party, being out with friends).

The primary goal of this study was to examine the relationship between drinking motives and the interpretation bias in problematic drinkers with and without mild to borderline intellectual disability (MBID, IQ 50–85; APA, 2013). Although the prevalence of alcohol use in individuals with MBID is generally lower compared to that in the general population (McGuire, Daly, & Smyth, 2007), they have been identified as a risk group for more severe negative consequences of alcohol use (e.g., health problems, social and interpersonal problems and emotional and behavioural problems; Slayter, 2008) and for developing problematic alcohol use (Burgard, Donohue, Azrin, & Teichner, 2000; McGillicuddy, 2006). However, the current knowledge on substance use (disorder) in individuals with MBID is scarce and there is a need for valid screening and assessment tools and effective treatment interventions (Carroll Chapman & Wu, 2012; Kerr, Darbyshire, Middleton, & Fitzsimmons, 2013; Van Duijvenbode et al., 2015). Studying the interpretation bias in problematic drinkers with MBID would be interesting, because it could provide new ways for the assessment and treatment of problematic alcohol use. For example, word association tasks provide indirect measures of high-risk situations for alcohol use or relapse (Woud et al., 2012) and could therefore be incorporated in relapse prevention strategies. In addition, preliminary evidence shows that the interpretation bias could be trained in cognitive bias modification procedures (Woud, Hutschemaekers, Rinck, & Becker, 2015b).

Recently, an interpretation bias has also been found in a comparable – but different – sample of problematic drinkers with MBID (Van Duijvenbode et al., in press). Problematic drinkers with and without MBID were asked to finish 24 short scenarios with their firs,

spontaneous response. The scenarios described positive, negative and neutral scenarios, such as a party, having a fight with your best friend and returning your new X-box to the store because it doesn't work properly (Woud et al., 2012). Problematic drinkers gave significantly more alcohol-related answers than light drinkers, which is indicative of an interpretation bias towards alcohol. Surprisingly, results showed that the interpretation bias was stronger in participants with MBID compared to participants without MBID. Explanations for these results remain speculative.

In this paper, we therefore seek to replicate our previous findings and expand the findings of Salemink and Wiers (2014) and Woud et al. (2015a) on the relationship between the interpretation bias and drinking motives, who have exclusively focused on samples of heavy drinking students. We used a cross-sectional research design to explore the relationship between the interpretation bias and drinking motives in light and problematic drinkers with and without MBID. Our first hypothesis was that, compared to light drinkers, problematic drinkers would show an interpretation bias towards alcohol and that the strength of this bias would be correlated with the severity of the alcohol use-related problems (see Stacy & Wiers, 2010). Considering that research on the interpretation bias in individuals with MBID is limited to our own previous study (Van Duijvenbode et al., in press), we conducted exploratory statistical analyses to study the role of full scale IQ on the strength and manifestation of the interpretation bias but did not formulate any a priori hypotheses about this role. Our second hypothesis was that participants' drinking motives would predict the interpretation bias for positive and negative scenarios in the word association task. More specifically, we hypothesised that enhancement motives would predict the bias score for positive scenarios and that coping motives would predict the bias score for negative scenarios (Salemink & Wiers, 2014; Woud et al., 2015a).

Method

Participants

Participants were recruited via two routes. First, participants were recruited from organisations within ID care (n = 47, 26.4%) and addiction medicine (n = 85, 47.8%). Second, participants were recruited via advertisements on social media, the Radboud University and word of mouth (n = 46, 25.8%). Exclusion criteria included being younger than 18 years old; currently experiencing withdrawal, psychotic or depressive/manic symptoms (as assessed by the treatment team); and no access to alcohol in the last 1.5 months. Participants with a history of problematic alcohol use who were currently abstaining for longer than 1.5 months were also excluded from participating (i.e., only current drinkers were included in the study). A preliminary check was conducted to see if the participants matched the inclusion criteria.

A total of 178 participants (131 men, 73.6%) with a mean age of 42.3 years (SD = 12.8, range = 18–68 years) were included in the study. The majority of the participants (n = 161, 90.4%) originated from the Netherlands. The other participants originated from Morocco/

Turkey (*n* = 6, 3.3%), Surinam/The Antilles (*n* = 3, 1.8%) or other Western and non-Western countries (*n* = 8, 4.5%). All participants spoke Dutch fluently. The educational background of participants differed markedly: 26 participants (14.6%) finished primary school, 38 participants (21.3%) finished special education, 32 participants (18.0%) finished secondary school, 41 participants (23.0%) finished vocational school and 38 participants (21.3%) finished university (college). Three participants (1.7%) had no completed education and six participants (3.4%) still attended vocational school or university (college). More than half of the participants (*n* = 102, 57.3%) were diagnosed with one or more psychiatric disorders, as assessed by the treatment team. In addition to substance use disorders (*n* = 87, 48.9%), anxiety disorders, autism spectrum disorders and attention deficit hyperactivity disorder were diagnosed most often (all *n* = 15, 8.4%). Twenty-two participants (12.4%) were diagnosed with a personality disorder. Eighty participants (44.9%) were prescribed psychotropic medication, including benzodiazepines, antipsychotics and antidepressants.

Measurements

Interpretation bias

The interpretation bias was measured using the open-ended, ambiguous scenarios developed by Woud et al. (2012). The scenarios were adapted to ensure feasibility in an adult, clinical sample of individuals with MBID (see Van Duijvenbode et al., in press). The task consisted of 24 scenarios (8 positive, 6 negative and 10 neutral scenarios) of a title and three lines, of which the last sentence ended abruptly (see Table 1). To control for carry-over effects, we used three different booklets with a different order of scenarios. The order of the booklets was balanced for time by a Latin square across participants (Keedwell & Dénes, 2015)[1]. All scenarios were read out loud to the participants and all answers were written down verbatim by the researcher. Participants were asked to finish each scenario with their first, spontaneous response. They were ensured there were no correct or incorrect answers. There was no time limit for the administration of the task. In line with Woud et al. (2014), the answers were then coded as binary variables (alcohol-related or unrelated/ambiguous) by two independent raters using a conservative rating system. Consensus scores agreed upon by both raters were used to calculate mean bias scores (i.e., total score, positive scenario score, negative scenario score, neutral scenario score) for each participant. Total bias scores ranged between 0 and 24, while the bias scores for positive, negative and neutral scenarios had a maximum of 8, 6 and 10 respectively. The interrater reliability was excellent, with Cohen's kappa = .99, $p < .001$ and percentages of agreement between the two raters ranging between 95.8% and 100%. The internal consistency of the bias scores ranged from poor for the bias score for positive scenarios (Cronbach's alpha = .46, mean inter-item correlation = .11) to questionable for the bias scores for neutral (Cronbach's alpha = .61, mean inter-item correlation = .46) and negative scenarios (Cronbach's alpha = .69, mean inter-item correlation = .28).

Table 1 Examples of the Positive, Negative and Neutral Scenarios used (Woud et al., 2012) and Possible Answers given by Participants, derived from Van Duijvenbode et al. (in press)

	Scenario	Possible answers
Positive scenario	**Movie night** Movie night at your friends house. "One more?", one of your friends asks. You cannot resist temptation and reach for a …	New film (alcohol-unrelated) Glass (ambiguous) Beer (alcohol-related)
Negative scenario	**Bad day** It is a horrible day and nothing works. You want to lose this bad feeling and treat yourself. You get a strong craving for …	Chocolate (alcohol-unrelated) A drink (ambiguous) Alcohol (alcohol-related)
Neutral scenario	**Poker** You play poker with your friends every other week. Everything is ready and the cards have been dealt. This time, your cards are very …	Good (alcohol-unrelated) Bad (alcohol-unrelated) Difficult to win with (alcohol-unrelated)

Substance use

Participants' general frequency and quantity of alcohol use was assessed with the Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q, VanDerNagel, Kiewik, Van Dijk, De Jong, & Didden, 2011b) and converted into standard units of 10g of alcohol to generate a measure of the weekly alcohol consumption by participants (International Center for Alcohol Policies, 2010). The severity of alcohol use-related problems was measured with the Alcohol Use Disorder Identification Test (AUDIT; Babor, Higgings-Biddle, Saunders, & Monteiro, 2001; Dutch translation: Schippers & Broekman, 2010). The AUDIT is a 10-item questionnaire about the amount, frequency and consequences of alcohol use with total scores ranging between 0 and 40. A score of 8 or more indicates hazardous alcohol use (Babor et al., 2001) and was used in this study to classify participants as either light drinkers (score < 8) or problematic drinkers (score ≥ 8). The internal consistency of the AUDIT in the current study was good (Cronbach's alpha = .91, mean inter-item correlation = .50).

Drinking motives

Drinking motives were assessed with the Drinking Motives Questionnaire Revised (Cooper, 1994). The DMQ-R is a 20-item questionnaire in which participants indicate the relative frequency of drinking for each of the four drinking motives (i.e., enhancement, coping, social and conformity motives). Each drinking motive is assessed with five questions (e.g., "I drink to forget my worries" or "I drink because it gives me a pleasant feeling"). The questionnaire was adapted to accommodate the population of individuals with MBID. Following the suggestions made by Hartley and MacLean (2006) and Finlay and Lyons (2001), a 4-point scale ranging from 0 (*almost never*) to 3 (*almost always*) was

used rather than the original 5-point scale to help participants with MBID differentiate between the options. Total scores therefore ranged between 0 and 15 for each of the four drinking motives. In addition, Figure 1 shows the visual aid of the options that was included to further help decision making (Bailey, Willner, & Dymond, 2011). The internal consistency of the DMQ-R in the current study was good, with a Cronbach's alpha of .89 (mean inter-item correlation = .28) for the total scale and Cronbach's alpha's of .82 for the Social subscale, .92 for the Coping subscale, .70 for the Enhancement subscale and .78 for the Conformity subscale.

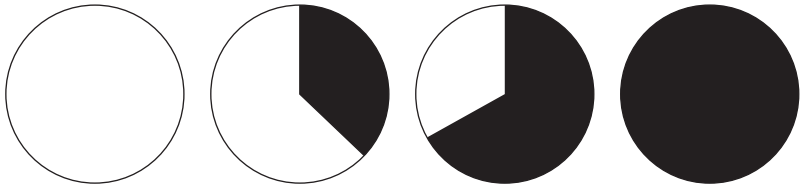


Figure 1 The visual aid that was used in the Drinking Motives Questionnaire Revised (Cooper, 1994) to indicate the frequency (from left to right: never, sometimes, most of the times, almost always) with which participants drank alcohol for a particular reason.

IQ

IQ was measured using the most recent scores on the Dutch version of the Wechsler Adults Intelligence Scale third edition (WAIS-III-NL; Uterwijk, 2000b) in the participants' files. If unavailable, a tetrad short form of the WAIS-III was administered (n = 122, 68.5%) consisting of two subtests for verbal IQ (Vocabulary and Similarities) and two subtests for performance IQ (Block design and Matrix reasoning). This test be administered in approximately 30 minutes and provides a reliable and valid estimate of full scale IQ in individuals with MBID (Van Duijvenbode, Didden, Van den Hazel, & Engels, 2016). Estimated full scale IQ was used to identify participants with MBID (IQ < 85) or without MBID (IQ ≥ 85).

Procedure

All participants provided written informed consent. The study consisted of one session of 1 to 1.5 h each. During this session, participants first provided general demographic information. If necessary, the tetrad WAIS-III short form was administered to estimate full scale IQ. Participants then completed the scenario task after which substance use and drinking motives were assessed. Finally, participants were thanked for their time and received a gift worth €5 (US $6.50, GBP £3.70) for their participation. The study was approved by the Ethics Committee of the Faculty of Social Sciences, Radboud University, Nijmegen, the Netherlands (ECG2012-1301-003).

Statistical analyses

All data were analysed using IBM SPSS Statistics (Version 20). A one-way ANOVA and chi-square analyses were conducted to compare demographic variables between the groups. To test our first hypothesis that problematic drinkers would show an interpretation bias towards alcohol, we calculated Pearson product-moment correlation coefficients between the severity of alcohol use-related problems (AUDIT score) and the bias scores. The bias scores were further investigated using one-sample *t*-tests to compare the mean bias scores to zero and independent samples *t*-tests to explore the differences between the two groups (light and problematic drinkers) in the strength of the bias. To also investigate the role of IQ, we conducted a 2 x 2 factorial ANOVA with severity of alcohol use-related problems (AUDIT score) and level of intellectual functioning (estimated full scale IQ) as between group factors. The second hypothesis regarding the relationship between the interpretation bias and participants' drinking motives was analysed using a Pearson product-moment correlation analysis and linear regression analyses. All variables were standardised using *z*-scores before they were entered into the regression (see Woud et al., 2015a). The bias scores for positive and negative scenarios were used as outcome variables in the regression analyses. The four drinking motives (i.e., enhancement, coping, social and conformity motives) were entered as predictor variables. None of the variables violated the assumption of normality. A post-hoc power analysis (with G*Power Version 3.1.92) showed that with the number of participants in the sample and the statistical tests used a power of .99 was achieved at a medium effect size ($f = .25$) and α of .05. An overview of the constructs, measures, hypotheses and results of the study is presented in Table 4.

Results

Group characteristics

Four groups were created based on the severity of alcohol use-related problems (AUDIT score) and intellectual functioning (estimated full scale IQ): light drinkers without MBID ($n = 40$), problematic drinkers without MBID ($n = 43$), light drinkers with MBID ($n = 41$) and problematic drinkers with MBID ($n = 54$). A one-way ANOVA with a post-hoc Tukey HSD test was conducted to compare demographic variables between the four groups (Table 2). With the exception of the expected differences in alcohol use and alcohol use-related problems, light and problematic drinkers did not differ significantly in demographic variables. Similarly, with the exception of estimated full scale, verbal and performance IQ, all demographic variables were identical between participants with and without MBID. A chi-square analysis showed that the groups also differed on gender ratio (χ^2 (3, $N = 178$) = 8.78, $p = .032$), with relatively few female problematic drinkers ($n = 18$, 10.1%)[1]. This was to be expected considering the gender differences in the prevalence of alcohol use (disorders) (Lev-Ran et al., 2013; Seedat et al., 2009). There were no differences on age and ethnic origin ($ps > .05$).

Table 2 Participant Characteristics per Group (N = 178): Light Drinkers without Mild to Borderline Intellectual Disability (MBID; n = 40), Problematic Drinkers without MBID (n = 43), Light Drinkers with MBID (n = 41), and Problematic Drinkers with MBID (n = 54)

		Without MBID		With MBID				
		Light drinkers	Problematic drinkers	Light drinkers	Problematic drinkers			
	Range	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*F* (3,174)	*p*	η_p^2
Age	18 – 68	41.50 (11.68)	46.53 (12.53)	39.68 (12.78)	41.48 (13.32)	2.32	.077	.04
Est. full scale IQ	45 – 115	103.18 (7.61)	92.88 (6.53)	67.05 (10.63)	75.00 (6.87)	177.11	< .001	.76
Est. verbal IQ	48 – 118	98.71 (10.04)	94.90 (7.45)	67.59 (11.31)	74.58 (9.57)	100.85	< .001	.65
Est. performance IQ	41 – 101	107.60 (9.23)	90.28 (10.26)	69.95 (12.29)	76.85 (7.90)	114.98	< .001	.68
AUDIT score[a]	0 – 37	4.88 (1.96)	22.74 (7.38)	3.51 (2.09)	22.44 (6.87)	169.86	< .001	.75
Weekly alcohol consumption[b]	0 – 490	4.13 (3.53)	123.05 (92.22)	3.85 (5.11)	119.96 (83.21)	48.60	< .001	.46

Note. AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001); η_p^2 = partial eta squared.

[a] Higher scores reflect more severe alcohol use-related problems (Babor et al., 2001).

[b] Weekly alcohol consumption was measured in standard units of 10g alcohol (International Center for Alcohol Policies, 2010).

Interpretation bias

To test our first hypothesis that problematic drinkers would show an interpretation bias towards alcohol, we first calculated Pearson product-moment correlation coefficients between the severity of alcohol use-related problems (AUDIT score) and the bias scores. As shown in Table 3, the severity of alcohol use-related problems correlated weakly to moderately with the total bias score ($r = .39$, $p < .001$), the bias score for positive scenarios ($r = .15$, $p = .043$) and the bias score for negative scenarios ($r = .48$, $p < .001$). A Fisher *r*-to-*z*-transformation indicated that the bias score for negative scenarios correlated significantly stronger with the severity of alcohol use-related problems than the bias score for positive scenarios (z difference = -3.48, $p < .001$). The severity of alcohol use-related problems did not correlate significantly with the neutral bias score ($r = .09$, $p = .23$). Estimated full scale IQ correlated weakly with the neutral bias score ($r = -.20$, $p = .009$), indicating that participants with a lower estimated full scale IQ gave more alcohol-related answers to neutral scenarios. Estimated full scale IQ did not correlate significantly with the other bias scores ($ps > .05$).

Second, we conducted one-sample *t*-tests to compare the mean bias scores to zero, meaning no bias. Mean bias scores for positive and negative scenarios are presented in Figure 2. Both light and problematic drinkers showed significant interpretation biases towards alcohol ($ps < .001$). An independent samples *t*-test indicated that the total bias score ($t(176) = 5.59$, $p < .001$, Cohen's $d = 0.84$) and the bias score for negative scenarios ($t(176) = 7.38$, $p < .001$, Cohen's $d = 1.11$), but not the bias score for positive scenarios ($t(176) = 1.89$, $p = .061$, Cohen's $d = 0.28$), differed significantly between light and problematic drinkers. Light and problematic drinkers did not show a significant bias score towards alcohol on neutral scenarios ($ps > .05$), nor did the bias score for neutral scenarios differ significantly between the two groups ($t(176) = 1.76$, $p = .08$, Cohen's $d = 0.27$).

The role of the severity of alcohol use-related problems and estimated full scale IQ in the (strength of the) interpretation bias was further investigated using a 2 x 2 factorial ANOVA. Main effects for severity of alcohol use-related problems and IQ as well as the interaction effects for the total bias score and the bias scores for positive and negative scenarios were investigated. There were significant interaction effects between the severity of alcohol use-related problems and IQ for the total bias score ($F(1,174) = 6.78$, $p = .010$, $\eta_p^2 = .04$) and the bias score for positive scenarios ($F(1,174) = 6.59$, $p = .011$, $\eta_p^2 = .04$). On both variables, problematic drinkers showed a stronger interpretation bias compared to light drinkers, with problematic drinkers with MBID showing particularly strong biases. In addition, the main effect for severity of alcohol use-related problems reached statistical significance for bias scores for negative scenarios ($F(1,174) = 52.51$, $p < .001$, $\eta_p^2 = .23$), with problematic drinkers showing stronger bias scores than light drinkers. All other main and interaction effects were not significant ($ps > .05$). These results remained when controlling for (estimated) verbal IQ and the neutral bias score in an ANCOVA.

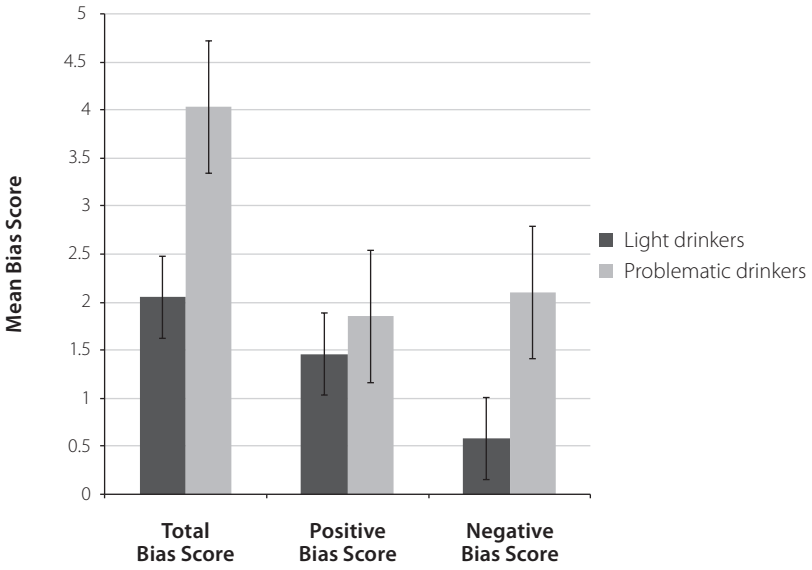


Figure 2 Mean and standard error of the total bias scores and bias scores for positive and negative scenarios separately for light drinkers (n = 81) and problematic drinkers (*n* = 97).

Relationship between interpretation bias and drinking motives

To test our second hypothesis regarding the relationship between the interpretation bias and participants' drinking motives, we first calculated Pearson product-moment correlation coefficients. As shown in Table 3, both the total bias score and the bias scores for positive and negative scenarios separately correlated weakly to moderately – yet significantly – with enhancement, coping and social drinking motives. Conformity drinking motives were not correlated significantly with the bias scores. The bias score for neutral scenarios did not correlate with any of the four drinking motives. When controlling for AUDIT score in a partial correlation analysis, the correlation between the bias scores and the coping drinking motive disappeared. All other significant results remained.

These results were supplemented with linear regression analyses to assess the predictive value of drinking motives for the bias scores for positive and negative situations. When predicting the bias scores for positive situations, the full model was statistically significant ($F(4,173) = 4.33$, $p = .002$) and explained 30.2% of the variance. The DMQ-R social motive was the only significant predictor ($\beta = .22$, $SE = .09$, $p = .019$). None of the other DMQ-R drinking motives predicted the bias score for positive scenarios significantly (β's ranging between .00 and .13).

Table 3 Correlation Matrix for Indices of IQ Severity of Alcohol Use-Related Problems (AUDIT Score and Weekly Alcohol Consumption), IQ (Estimated Full Scale, Verbal and Performance IQ), the Interpretation Bias and Drinking Motives.

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	AUDIT score	–												
2	Weekly alcohol consumption	.79**	–											
3	Est. full scale IQ	-.03	-.05	–										
4	Est. verbal IQ	.06	.04	.92**	–									
5	Est. performance IQ	-.15	-.16*	.92**	.71**	–								
6	Total bias score	.39**	.32**	-.03	-.00	-.00	–							
7	Positive bias score	.15*	.10	.04	.04	.11	.82**	–						
8	Negative bias score	.48**	.41**	-.04	.01	-.07	.87**	.45**	–					
9	Neutral bias scores	.09	.10	-.20**	-.24**	-.16*	.22**	.09	.10	–				
10	DMQ-R enhancement	.56**	.47**	-.03	-.00	-.11	.40**	.25**	.42*	.10	–			
11	DMQ-R coping	.81**	.64**	-.08	-.01	-.18*	.39**	.17*	.49**	.00	.65**	–		
12	DMQ-R social	.26**	.21**	.10	.07	.07	.34**	.27**	.31**	.04	.54**	.30**	–	
13	DMQ-R conformity	.11	.15	-.06	-.04	-.06	.12	.10	.10	-.02	.33**	.27**	.43**	–

Note. * $p < .05$, ** $p < .01$; AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001); DMQ-R = Drinking Motives Questionnaire Revised (Cooper, 1994).

Table 4 Narrative Description of the Constructs, Measures, Hypotheses and Results of the Study

Construct	Measure	Hypothesis	Result
Interpretation bias	Word association task (24 positive, negative and neutral scenarios), adapted from Woud et al. (2012)	1) Problematic drinkers show an interpretation bias towards alcohol	1) Hypothesis is confirmed. Problematic drinkers gave significantly more alcohol-related answers than light drinkers.
		2) The strength of the bias correlates significantly with the severity of alcohol use-related problems	2) Hypothesis is confirmed. The strength of the bias correlated significantly with the severity of alcohol use-related problems.
IQ	Wechsler Adults Intelligence Scale third edition (Uterwijk, 2000)	No a priori hypotheses (exploratory analyses)	Interaction effect between est. full scale IQ and the total bias score; Interaction effect between est. full scale IQ and the bias score for positive scenarios; Weak correlation between est. full scale IQ and the bias score for neutral scenarios.
Drinking motives	Drinking motives questionnaire revised (subscales: enhancement, coping, social and conformity motives; Cooper, 1994)	1) Enhancement motives predict the bias for positive scenarios	1) Hypothesis not confirmed. Social drinking motives predicted the bias for positive scenarios.
		2) Coping motives predict the bias for negative scenarios	2) Hypothesis partly confirmed. Social and coping drinking motives predicted the bias for negative scenarios.

The model for the bias scores for negative scenarios also reached statistical significance ($F(4,173) = 16.79$, $p < .001$) and explained 52.9% of the variance. Both the DMQ-R social motive ($\beta = .18$, $SE = .08$, $p = .030$) and coping motive ($\beta = .38$, $SE = .08$, $p < .001$) significantly predicted the bias score for negative scenarios. The other two drinking motives (i.e., enhancement and conformity) did not significantly predict the bias score for negative scenarios ($\beta = .11$, $SE = .10$, $p = .277$; $\beta = -.11$, $SE = .07$, $p = .135$; respectively).

Discussion

Problematic alcohol use has repeatedly been associated with cognitive biases in information processing, including an interpretation bias or a tendency to interpret ambiguous, alcohol-relevant cues in an alcohol-related way. Considering the influence of contextual cues (e.g., cognitive, social and affective states) on memories, associations and interpretations (Krank & Wall, 2006), the goal of the present study was to explore the relationship between the interpretation bias and drinking motives in problematic drinkers with and without mild to borderline intellectual disability (MBID).

Our first hypothesis was that problematic drinkers with and without MBID would show an interpretation bias towards alcohol. The results supported this hypothesis. Problematic drinkers had a tendency to interpret ambiguous, alcohol-relevant cues in an alcohol-related way and the strength of this bias correlated significantly – albeit weakly to moderately – with the severity of alcohol use-related problems. Similar results have consistently been found in previous studies using word association paradigms (e.g., Ames et al., 2005; Krank, et al., 2010; Woud et al., 2012, 2014), including in our previous study using a comparable sample of problematic drinkers with and without MBID (Van Duijvenbode et al., in press). Two of our results stand out. First, although problematic drinkers showed an interpretation bias in both positive and negative scenarios, the bias was especially strong in negative scenarios. Although this is consistent with the literature on drinking motives in clinical samples (e.g., Carpenter & Hasin, 1999; Mezquita et al., 2011) showing problematic drinkers often drink alcohol to cope with unpleasant emotions such as stress, anxiety and depression, this explanation remains speculative because enhancement motives have also frequently been found among problematic drinkers (e.g., Cadigan, Martens, & Herman, 2015). Second, in line with our previous study (Van Duijvenbode et al., in press) we found the total bias score to be particularly high in problematic drinkers with MBID. These results remained when controlling for (estimated) verbal IQ, suggesting that verbal capacity does not play a role in the assessment of the interpretation bias. One possible explanation for our results is the increased vulnerability to probing questions or a tendency to please others – as a result of which they could have responded in accordance with the research goals more often than individuals without MBID (Finlay & Lyons, 2001; Finlay & Lyons, 2002). Another possible consideration is that

the alcohol construct was more accessible to participants with MBID than to participants without MBID, because estimated full scale IQ correlated negatively with the bias score for neutral scenarios. However, both explanations remain speculative and need to be further studied in future research.

Our second hypothesis was that the interpretation bias for positive and negative scenarios would be related to participants' drinking motives. More specifically, we expected that the bias score for positive, enjoyable scenarios would be related to enhancement motives and the bias score for negative, stressful scenarios to be related to coping motives (Salemink & Wiers, 2014; Woud et al., 2015a). Our results partially support this hypothesis. In line with our expectations we found that coping motives predicted the strength of the interpretation bias in negative scenarios. These results indicate that coping drinkers have formed a strong associative relationship between unpleasant emotions, alcohol use and tension reduction by repeatedly drinking alcohol in response to experiencing unpleasant emotions or negative situations. Hence, when confronted with such negative situations, their alcohol-related memory schemata become activated, increasing the chances of alcohol use in these situations. In contrast with our expectations, however, positive situations *also* activated alcohol-related schemata in coping drinkers. Steward, Hall, Wilkie and Birch (2002) and Birch et al. (2006) found similar results and concluded that both positive and negative scenarios activate the alcohol network of coping drinkers, perhaps because they associate alcohol use both with reducing unpleasant emotions as well as with enhancing pleasant emotions. Indeed, in two studies with college students, both Littlefield, Vergés, Rosinkski, Steinley and Sher (2013) and Cadigan et al. (2015) found that coping and enhancement drinkers do not form two distinct groups, but rather often drink for both enhancement and coping motives combined. This would explain why coping drinkers show an interpretation bias to both positive and negative scenarios. Also contrary to the expectations, we found that social motives but not enhancement motives predicted the strength of the interpretation bias in positive scenarios. This means that individuals who drink alcohol to facilitate or improve social relationships or to enhance enjoyment in social situations tend to interpret positive scenarios with alcohol use. We offer two possible explanations. First, research among adolescents has concluded there is considerable overlap between the enhancement and social drinking motives (e.g., Read, Wood, Kahler, & Maddock, 2003; Steinhausen & Metzke, 2003). Second, and related, our results could be explained by the nature of the scenarios in the word association task. As the positive scenarios mostly describe pleasant situations with others (e.g., a party, being with friends), these scenarios likely tap into social drinking motives more than into enhancement motives (see Woud et al., 2015a).

We note several limitations to the current study. First, participants were aware that they were participating in a study on alcohol use. This could have biased their response, for example by censoring their responses in line or in contrast with the research goals. As described above and as suggested in our previous study (Van Duijvenbode et al., in press),

this could explain the stronger interpretation bias found in individuals with MBID and should be taken into account in future research on this topic. Second, the questionnaires used to measure the severity of alcohol use-related problems (AUDIT; Babor et al., 2001) and drinking motives (DMQ-R; Cooper, 1994) have not been validated for individuals with MBID. Because questions that require a judgement of frequency or amount and questions about general behavioural patterns have been proven to be difficult in individuals with MBID (Finlay & Lyons, 2001), the reliability and validity of the questionnaires and the cut-off scores of the AUDIT can be questioned despite the adaptations we have made to increase feasibility. Although the reliability of the AUDIT and DMQ-R were moderate to good in the current study, research could be directed at further validating these questionnaires for individuals with MBID. Third, the internal consistency of the bias scores was poor to questionable. Although this seems problematic, one of the strengths of the word association tasks is that it allows for individual differences in the associative network (Woud et al., 2012). This means that while some scenarios might be associated with alcohol use, others might not – depending on contextual cues and personal memories. This then might explain the internal consistency scores of the bias scores. However, as previous studies using similar tasks have not reported internal consistency scores, this could be addressed in future research on the topic. Fourth, we used a cross-sectional design to study the relationship between the interpretation bias and drinking motives in problematic drinkers with and without MBID. This does neither allow us to draw conclusions about causality, nor does it provide insight in the role of the interpretation bias and drinking motives in the development and maintenance of problematic alcohol use. Future research should therefore use a prospective design to study the causal relationship between the interpretation bias, drinking motives and severity of alcohol use-related problems. This would not only identify the factors related to the development of the interpretation bias, but would also enhance our understanding of the role of the interpretation bias in the development and maintenance of problematic alcohol use in general. Last, we solely focused on drinking motives in relation to the interpretation bias. Previous research suggests, however, that other contextual cues, such as mood and alcohol expectancies, can also influence the memory, associations and interpretations (Krank & Wall, 2006). Future studies could therefore be directed at expanding our results by also taking these constructs into account and further disentangling the circumstances that trigger the activation of the interpretation bias in problematic drinkers.

To conclude, this study adds to the knowledge base on the underlying mechanisms of problematic alcohol use. From a scientific point of view, our results seem to provide evidence for disruptions in the reward and information processing systems of the brain associated with chronic and/or excessive alcohol use (Koob, 2013; Volkow et al., 2013). More specifically, the results indicate that problematic drinkers with and without MBID tend to interpret ambiguous, alcohol-relevant situations in an alcohol-related way, but that the activation of this interpretation bias might depend on individual differences in

individuals' motivational schema. Our results show that the interpretation bias is stronger in participants with MBID compared to those without MBID. With regard to the relationship between the interpretation bias and drinking motives, it was shown that social motives can predict the interpretation bias in positive scenarios, while coping and social motives do so in negative scenarios. From a clinical point of view, our results therefore imply that treatment procedures should be tailored to individual differences in drinking motives and alcohol-related associations (e.g., by choosing a course of treatment that is consistent with drinking motives and situations that are associated with alcohol use). Word association tasks such as the one adopted in the current study could be used to identify potential high-risk situations for alcohol use and relapse and could provide a novel way of treating problematic alcohol use by way of an interpretation retraining procedure (see Kelly, Masterman, & Marlatt, 2005). Woud et al. (2015b) have found preliminary evidence for the feasibility of this kind of cognitive bias modification procedures, in which problematic drinkers are trained to interpret ambiguous alcohol-relevant scenarios in a neutral manner (but see Christiansen, Schoenmakers, & Field, 2015; Field, Marhe, & Franken, 2013 for critique on cognitive bias modification procedures in the field of problematic alcohol use). Our results therefore provide a new line of inquiry to improve the assessment and treatment of problematic alcohol use in individuals with and without MBID.

Footnotes

[1] We controlled for booklet number and gender in all analyses, but they had no effect. Therefore, only the results without booklet number and gender as controlling variables are reported.

PART II

Controlled processing

750 ML

ALC. 11,5%

9

Executive control in long-term abstinent problematic drinkers with mild to borderline intellectual disability

This chapter has been published as:
Van Duijvenbode, N., Didden, R., Korzilius, H. P. L. M., Trentelman, M., & Engels, R. C. M. E. (2013). Executive control in long-term abstinent alcoholics with mild to borderline intellectual disability: The relationship with IQ and severity of alcohol use-related problems. *Research in Developmental Disabilities, 34*, 3583–3595.

Abstract

Deficits in executive control might be related to alcohol abuse in individuals with mild to borderline intellectual disability (MBID). The goal of the present study was to test the relationship between executive control (i.e., working memory capacity, inhibitory control and delay discounting), IQ and chronic alcohol use. Participants ($N = 40$) were divided into four groups based on IQ and severity of alcohol use-related problems (heavy and light drinkers with and without MBID). They were all admitted to a psychiatric treatment facility and long-term abstinent at the time of testing. Contrary to the expectations, executive control was not consistently impaired among individuals with MBID. Results showed that working memory capacity did seem to be impaired, whereas inhibitory control and delay discounting did not. Moreover, there were no differences between heavy and light drinkers on any of the parameters and having a dual diagnosis (heavy drinkers with MBID) did not result in additive negative effects on executive control. It is suggested that alcohol-related cognitive impairment is temporary and decreases over time after cessation of drinking.

Introduction

Individuals with mild to borderline intellectual disability (MBID; IQ 50–85, American Psychiatric Association, 2000; Schalock et al., 2010) have a relatively high risk of alcohol abuse and dependency after initial use compared to individuals without intellectual disability (Didden, Embregts, Van der Toorn, & Laarhoven, 2009). Research in individuals without intellectual disability showed that deficiencies in executive control are both predictors of alcohol use-related problems (Verdejo-García, Lawrence, & Clark, 2008) as well as consequences of chronic alcohol use (Bechara & Martin, 2004; Kamarajan et al., 2005). As individuals with MBID often show deficiencies in executive control (Danielsson, Henry, Rönnberg, & Nilsson, 2010; Willner, Bailey, Parry, & Dymond, 2010a), indicating difficulty in controlling and regulating behaviour, this may be a partial explanation for the increased risk of alcohol use-related problems. In the present study, we therefore studied the relationship between executive control, IQ and chronic alcohol use.

According to contemporary dual process models (see e.g., Bechara, Noel, & Crone, 2006), the development and maintenance of drug seeking behaviour are caused by implicit and explicit processes. Implicit processes are fast, automatic and hard to control, while explicit processes are deliberate, slow and require conscious awareness (Strack & Deutsch, 2004). A previous study found no influence of IQ on the strength of these implicit processes (Van Duijvenbode, Didden, Voogd, Korzilius, & Engels, 2012b). Dual process models further hypothesise that executive control and motivation for taking alcohol moderate the effect of implicit processes on drug seeking behaviour (Fazio & Olson, 2003): mental representations activated by alcohol cues are less likely to influence behaviour among people with strong executive control. Executive control is an umbrella term for cognitive processes used to control and regulate behaviour including goal-setting, planning and organising behaviour and mental flexibility (Meltzer, 2007). Indeed, research shows that deficient executive control can be described as a vulnerability marker for alcohol use-related problems (Verdejo-García et al., 2008).

Following this line of reasoning, it can be hypothesised that individuals with MBID may be more vulnerable to developing alcohol use-related problems due to deficiencies in executive control often found in this target group (Danielsson et al., 2010; Willner et al., 2010a). For example, research has shown that individuals with MBID can hold less information in working memory, indicating a smaller working memory capacity (Lanfranchi, Jerman, Dal Pont, Alberti, & Vianello, 2010; Rowe, Lavender, & Turk, 2006), and differences between individuals with MBID and typically developing controls with the same mental age increase when the stored information needs to be actively manipulated (Carretti, Belacchi, & Cornoldi, 2010; Numminen, Service, & Ruoppila, 2002). Similarly, Brunamonti et al. (2011) and Rose, Bramham, Young, Paliokostas and Xenitidis (2009) studied inhibitory control in individuals with MBID and found that they have more difficulty suppressing a prepotent response than controls. Of interest to this topic is also

delay discounting, which refers to the decrease in value of a potential reward as a function of the delay to its receipt and is measured by assessing preferences between a sooner, smaller reward or a later, larger one (Kirby & Petry, 2004). It has been suggested that the concept of delay discounting is related to both executive control (Shamosh et al., 2008) and IQ (De Wit, Flory, Acheson, McCloskey, & Manuch, 2007) with individuals with a lower IQ and weaker executive control performing more impulsively on these tasks (but see Willner, Bailey, Parry, & Dymond, 2010b for an alternative explanation).

In addition to deficient executive control as a vulnerability marker that predates alcohol use-related problems, alcoholics also show deficits in executive control as a consequence of chronic alcohol use. Of the three core executive functions proposed by Miyake, Friedman, Emerson, Witzki and Howerter (2000) – set shifting, working memory updating and response inhibition – primarily working memory updating (Bechara & Martin, 2004; Grenard et al., 2008) and response inhibition (Kamarajan et al., 2005; Li, Luo, Yan, Bergquist, & Sinha, 2009) seem to be affected. Alcoholics also show increased delay discounting compared to non-drinking controls (for a review, see MacKillop et al., 2011). Moreover, deficits in executive control do not fully disappear after cessation and have also been found in detoxified alcoholics who had been abstinent for several weeks or even years (Fein, Klein, & Finn, 2004; Petry, 2001). This means that, according to the dual process models, alcoholics will remain vulnerable for relapse even long after cessation.

To the best of our knowledge, there is no research on executive control in alcoholics with MBID and the role of working memory, inhibitory control and delay discounting in the development and maintenance of and their relationship with alcohol use-related problems. Further, little is known about the additive effects of MBID and chronic alcohol use on executive control. Research on this topic is necessary because it may have implications for treatment of alcohol use-related problems (Petry, 2001). In a study of O'Leary and colleagues (1979; in Davies et al., 2005), for example, it was concluded that cognitive dysfunction was related to a smaller likelihood of successful completion of inpatient treatment, more relapses, shorter periods of abstinence and higher rates of alcohol consumption after one year.

We therefore conducted a study in which we compared individuals with and without a history of alcohol use-related problems (heavy vs. light drinkers) and varying in IQ (IQ: 50–120). Our goal was to test the relationship between executive control (i.e., working memory capacity, inhibitory control and delay discounting), IQ and chronic alcohol use. Firstly, we hypothesised that, on average, participants with MBID would have a smaller working memory capacity, would have poorer inhibitory control and would discount monetary delays faster than individuals with an average IQ (Danielsson et al., 2010; Willner et al., 2010a). Secondly, although all participants were detoxified and abstinent at the time of testing, we expected heavy drinkers to perform worse on the executive control tasks (i.e., have a smaller working memory capacity, have poorer inhibitory control and would discount monetary delays faster) than light drinkers (Fein et al., 2004; Petry, 2001).

Lastly, we expected that the combination of MBID and a history of alcohol use-related problems would have an additive effect on executive control and that these participants would therefore perform worse on the executive control tasks compared to the other participants.

Method

Participants

Participants (N = 40; 36 men) had a mean age of 41.10 years (SD = 11.51). Seventy-five percent of the participants (n = 30) had completed primary school, while only a minority had completed secondary school (12.5%, n = 5) or vocational school (5.0%, n = 2). Three participants (7.5%) had not finished primary school. Substance use-related disorders (62.5%, n = 25) and personality disorders (75.0%, n = 30) were diagnosed most often. There was a high co-morbidity rate between the disorders and participants were often diagnosed with multiple disorders. All participants had normal or corrected to normal vision and spoke Dutch fluently. All participants had the Dutch nationality and the majority (82.5%, n = 33) originated from the Netherlands.

All participants were either voluntarily (n = 3) or involuntarily (n = 37) admitted to forensic psychiatric centre Oldenkotte or psychiatric treatment facility Trajectum (formerly Hoeve Boschoord). They were selected based on IQ and the severity of alcohol use-related problems in the past. As Trajectum is a facility specialised in the treatment and care of individuals with MBID (IQ: 50–85; n = 20), participants with below average/average IQ (IQ: 85–120; n = 20) were recruited from FPC Oldenkotte. Participants with a history of alcohol use-related problems were recruited from both organisations. Severity of alcohol use-related problems was measured by the Alcohol Use Disorders Identification Test (AUDIT; Babor, Higgings-Biddle, Saunders, & Monteiro, 2001; Dutch translation: Schippers & Broekman, 2010). Only individuals who were considered total abstainers or light drinkers (AUDIT score < 8; n = 20) or heavy drinkers (AUDIT score ≥ 16; n = 20) could participate. Alcohol is not available in the treatment facilities and all participants were abstinent at the time of testing.

The study was approved by the Committee of Ethics of the Faculty of Social Sciences, Radboud University Nijmegen, the Netherlands.

Material

Executive control tasks

Five executive control tasks targeting working memory capacity, inhibitory control and delay discounting were used. All tasks were presented in Inquisit software version 3.0.6.0 (Millisecond, 2011) on a 17-inch laptop.

Working memory capacity

The Corsi block tapping task (Corsi, 1972) and the Self-ordered pointing task (Petrides & Milner, 1982) were used to measure working memory capacity.

The Corsi block tapping task consisted of two practice trials followed by up to 16 critical trials which gradually increased in length. Participants were shown 9 blue 30 x 30 mm blocks, portrayed at their standard positions (for the exact coordinates of the blocks, see Kessels, Van Zandvoort, Postma, Kappelle, & De Haan, 2000) on a black background (255 x 205 mm, see Figure 1A). In each trial, a sequence of blocks was highlighted by changing the block colour from blue to yellow for 1000 ms. After two trials of equal length, one block was added to the sequence. The task started with a sequence of two blocks which increased to a maximum of 9 blocks per sequence. The time between erasing a previously highlighted block and highlighting the next one was 450 ms. The time between the last highlighted block and the start of the participant's action was also 450 ms. Participants were instructed to repeat the shown sequence in the correct order by clicking on the respective boxes with a computer mouse. Self-corrections were permitted. The test terminated automatically if the participant failed to reproduce both sequences of equal length correctly. Block span (the length of the longest correctly reproduced sequence) and the total score (the number of the correct trials) were scored (Kessels et al., 2000).

The Self-ordered pointing task (SOPT) consisted of six blocks of three trials. In each trial, participants were shown a series of screens with a number of pictures derived from Rossion and Pourtois (2004). The number of pictures on the screen increased in each block (3, 4, 6, 8, 10 and 12 pictures). For an example of a screen see Figure 1B. The position of the pictures was rearranged randomly in each screen and participants were instructed to click on a different picture on every screen. The pictures remained on the screen until the participant's response. The inter-trial interval was 500 ms. Participants were prevented from clicking on the pictures in alphabetical order as well as repeatedly clicking on the same location on different screens. The SOPT score (the number of selections minus the number of errors), the total number of errors and the perseverative error score (the total number of times a participant pointed consecutively to the same stimulus within a trial) were recorded for analysis (Ross, Hanouskova, Giarla, Calhoun, & Tucker, 2004).

Inhibitory control

Inhibitory control was measured using the Go/No-go task (Newman & Kosson, 1986) and the Stop signal task (Logan, Cowan, & Davis, 1984).

The Go/No-go task consisted of one practice block of 20 trials, followed by four test blocks of 25 trials. Each trial started with the presentation of a fixation point (+) for 800 ms followed by a blank white screen for 500 ms. Then a cue appeared in the centre of the screen for one of five randomly selected stimulus onset asynchronies (SOAs; 100, 200, 300, 400 and 500 ms). Using different SOAs encourages participants to pay attention to the

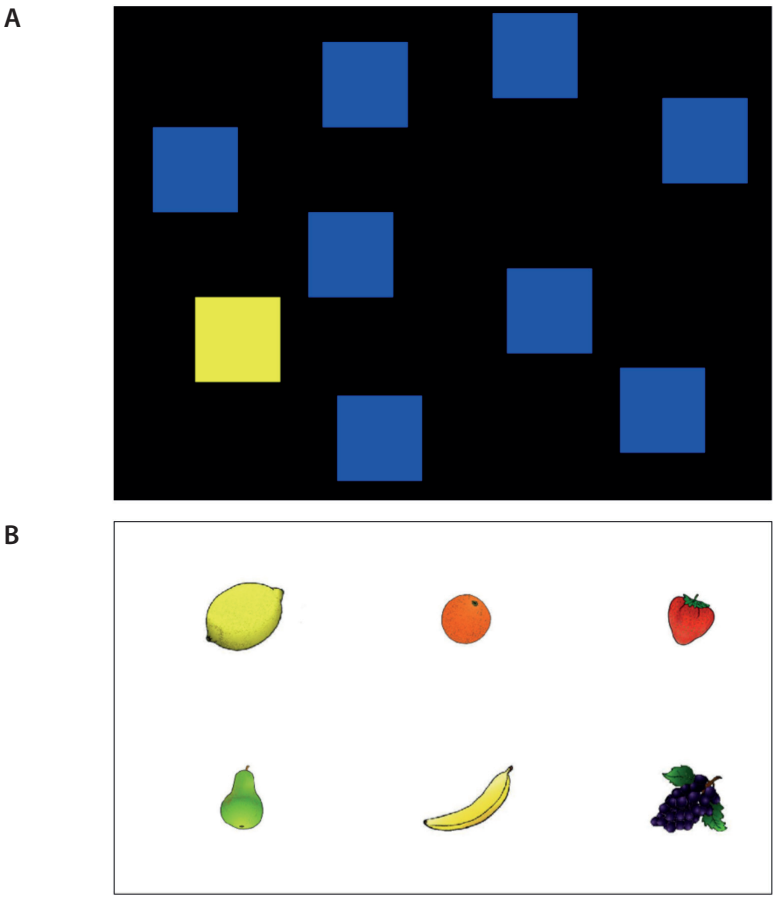
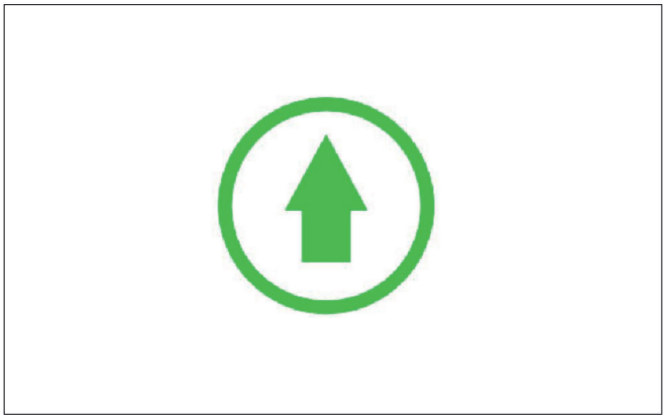


Figure 1 An overview of the executive control tasks. (**A**) shows the Corsi block tapping task (Corsi, 1972). The yellow block symbolises the current block in the sequence. In (**B**) a screen in the six item block of the Self-ordered pointing task (Petrides & Milner, 1982) is shown. The pictures are derived from Rossion and Pourtois (2004). The position of the pictures rearranges randomly when the participant clicks on one of the picture with a computer mouse. An example of a go trial on the Go/No-go task (Newman & Kosson, 1986) is shown in (**C**). Participants were instructed to press a space bar as quickly as possible on go trials and withhold from responding on the no-go trials. (**D**) Shows a trial of the Stop signal task (Logan et al., 1984). Participants were instructed to indicate the direction in which the arrow was pointing by pressing one of two keys. The Delay discounting task (Rachlin et al., 1991) is shown in (**E**). In this task participants were asked to make a series of decisions between a sooner, smaller or a later, larger hypothetical monetary reward.

C



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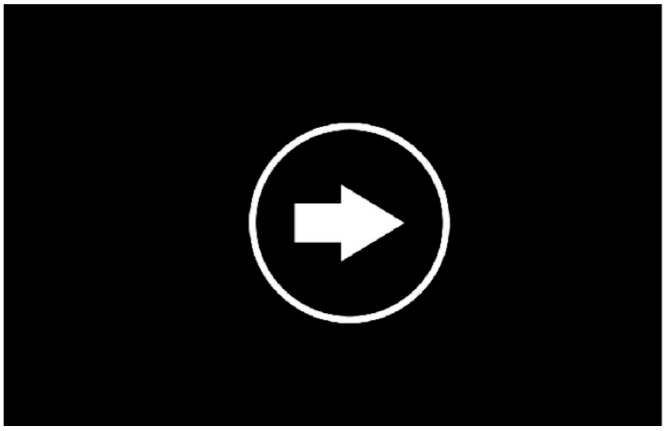

E

Figure 1 Continued.

cues and prevents them from anticipating the onset of the next target (Fillmore, Rush, & Hays, 2006). The cue was an arrow (750 x 480 mm) surrounded by a 90 mm black outlined ring, which was presented pointing up or down (both 50%). The presentation of the cue was followed by a go or no-go target, which were green or red coloured cues, respectively. The go: no-go ratio was 4:1. The targets remained on the screen until a response was made or 1250 ms had elapsed. The inter-trial interval was 700 ms. Participants were instructed to press the space bar as quickly as possible whenever the cue turned green (go trial, see Figure 1C), irrespective of the direction of the arrow. They were instructed not to respond whenever the cue turned red (no-go trials). The dependent measure of this task was the number of commission errors (inappropriate responses to a no-go target, or inhibition error; Fillmore et al., 2006; Reynolds, Ortengren, Richards, & De Wit, 2006). Reaction times (RTs) below 200 ms, above 2000 ms and more than 2.5 *SD*s above the mean were considered outliers and were excluded from analyses (5% of the data).

The Stop signal task we used was closely modelled on the task developed by Verbruggen, Logan and Stevens (2008). It consisted of 20 practice trials, followed by four test blocks of 50 trials which were separated by a 15 s break. Each trial started with a black screen for 500 ms, followed by a cue presented in the centre of the screen. The cues were similar to the ones used in the Go/No-go task, but were pointing to the left or right instead (see Figure 1D). The cue remained on the screen until a response was made or 1250 ms had elapsed. The inter-trial interval was 500 ms. Participants were instructed to indicate the direction in which the arrow was pointing by pressing one of two keys (*D* and *K*) as quickly as possible. On 50 trials (25%), a stop-signal (750 Hz, 75 ms) was presented after the onset of the cue. Participants were instructed to withhold their response if they heard this signal. Five different stop-signal delays (SSDs, the delay between the presentation of the cue and the stop-signal; 150, 200, 250, 300 and 350 ms) were used. The SSD was initially set at 250 ms and was adjusted according to the staircase tracking procedure (Verbruggen et al., 2008), meaning that the SSD increased by 50 ms after a successful inhibition and decreased by 50 ms after an unsuccessful inhibition. The dependent measures were the stop signal RT (SSRT; an estimation of the time the participant needs to stop the prepotent response on a stop-trial), the mean SSD, the mean *p* (the mean probability of responding on stop-trials) and the number of inhibition errors. Reaction times below 200 ms, above 2000 ms and more than 2.5 *SD*s above the mean were considered outliers and were excluded from analyses (< 1% of the data).

Delay discounting

The Delay discounting task (Rachlin, Ranieri, & Cross, 1991) was included as an index for delay discounting. Participants were asked to make a series of decisions between a sooner, smaller or a later, larger hypothetical monetary reward. For example, participants would have to choose between receiving €65 now or €100 in two days (see Figure 1E). Hypothetical rewards were used because previous studies found no significant differences

between delay discounting tasks using real or hypothetical monetary rewards (Madden et al., 2004). The delayed reward was fixed at €100 and the value of the immediate reward gradually decreased (€99, €95, €92, €90, €85, €80, €75, €70, €65, €60, €55, €50, €45, €40, €35, €30, €25, €20, €15, €10, €8, €6, €4, €2, €1, €0.50 and €0.20). Both options remained on the screen until the participants made their choice by clicking on the preferred reward with a computer mouse. The inter-trial interval was 500 ms. After completing a block, the task continued in the reversed order (from €0.20 to €99). Then, participants were presented with the next block with the next length of delay to delivery of the delayed reward (1 day, 2 days, 1 week, 2 weeks, 1 month, 6 months and 2 years). The task therefore consisted of 14 blocks (seven delays presented in two orders) of 27 choices each. The order of presentation was counterbalanced.

Indifference points were calculated for each length of delay to delivery by averaging the switching point on both orders (from €99 to €0.20 and from €0.20 to €99). The area under the curve (AUC) methodology was then used for the calculation of delay discounting (Myerson, Green, & Warusawitharana, 2001). A small AUC reflects steep temporal discounting, i.e. impulsive decision making. In addition, inconsistency and complexity measures were calculated for each participant (Willner et al., 2010b). Inconsistency reflects the extent to which choices are made in a disorderly fashion. In a typical delay discounting curve, which follows a hyperbolic function, the indifference points should decrease as the delays to receiving the larger reward increase. As described in Willner et al. (2010b), inconsistency is therefore defined as the number of times the indifference points increased with increasing delays (the inconsistency score is 0 in Figure 2A and 2 in Figure 2B). Complexity is the extent to which participants used both the temporal and financial dimension in their decision. Relatively high scores are indicative for focusing on just the financial dimension whereas low scores are representative for mainly considering the temporal dimension. Complexity scores per time delay was 1 when participants had an indifference score of either above 95.0 or below 1.0 and 0 when participants had an indifference score below 95.0 or above 1.0 (range 0–7). The total score across all time delays was used as an index of complexity in decision making.

Intelligence

Intelligence was measured using the most recent (< 5 years old) scores on the Dutch version of the Wechsler Adults Intelligence Scale third edition (WAIS-III-NL; Uterwijk, 2000b). If IQ was unknown, a four-subtest version of the WAIS-III-NL rather than a full-length WAIS-III was conducted due to time constraints and potential problems with participant fatigue. The WAIS-III short-form consisted of four subtests (Vocabulary, Similarities, Block Design and Matrix Reasoning) and was administered in approximately 30 min. To ensure consistency in estimated (est.) IQ scores, Total, Verbal and Performance IQs of all participants were estimated using the standardised scores of these four subtests according to a mathematical analysis described in Crawford, Allum and Kinion (2008).

The relationship between Total, Verbal and Performance IQ according to the full-length WAIS-III and the short-form (N = 24) was examined using Pearson product-moment correlation coefficient. There were strong, positive correlations between both measures (Total IQ: r = .93, p < .001; Verbal IQ: r = .93, p < .001; Performance IQ: r = .78, p < .001), indicating that our short-form provided a valid estimate of the participants' IQ.

Substance use

The Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q; VanDerNagel, Kiewik, Van Dijk, De Jong, & Didden, 2011b) was used to assess history of alcohol and drug use. Severity of drug use-related problems in the past was measured by the Drug Use

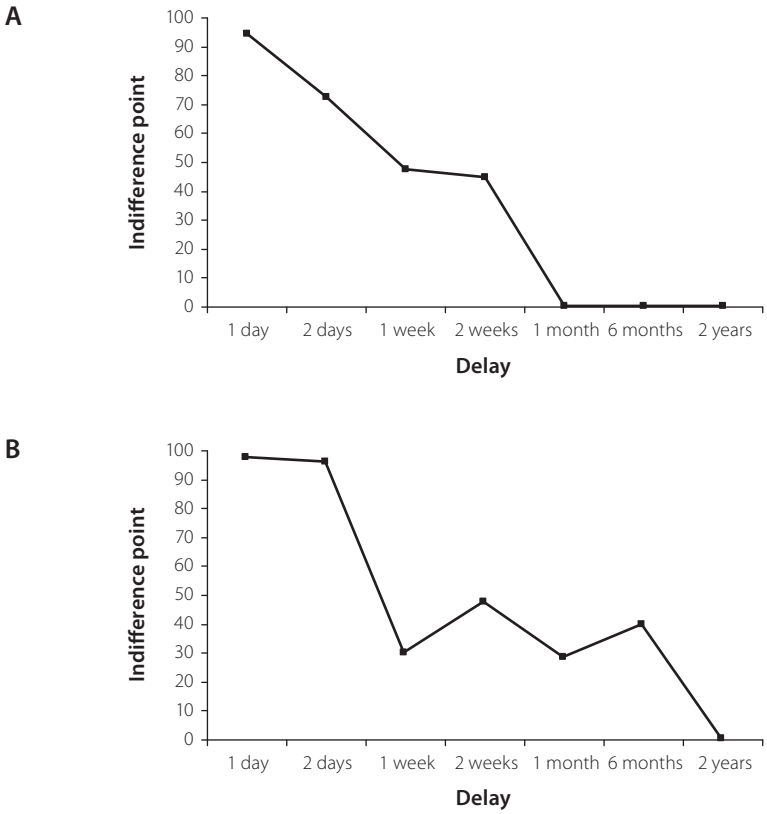

Figure 2 Delay discounting curves of two participants showing the relationship between the value of the immediate reward as a function of the length of delay. Figure 2A represents onse pattern (inconsistency score = 0), while the response pattern in Figure 2B is inconsistent (inconsistency score = 2).

Disorders Identification Test (DUDIT; Berman, Bergman, Palmstierna, & Schlyter, 2003; Dutch translation: Kraanen & Fluttert, 2008). Likewise, severity of alcohol use-related problems in the past was measured by the AUDIT (Babor et al., 2001; Schippers & Broekman, 2010). The AUDIT is a standardised questionnaire of 10 questions about the amount, frequency and consequences of drinking alcohol. Scores range between 0 and 40. In addition, the average weekly alcohol consumption, measured in standard units of 10g of alcohol (International Center for Alcohol Policies, 2010), was used as a measure of participants' drinking patterns in the past.

Procedure

Fifty-five patients from both psychiatric treatment facilities were approached by the researcher (first author): 42 agreed to participate and gave their informed consent (76%). Two participants dropped out prior to testing, leaving a total *N* of 40. The experiment lasted approximately 2 h and was spread out across two sessions of 1 h each.

During the first session, participants provided general demographic information. Alcohol and drug use in the past was assessed and the short-form of the WAIS-III was conducted if necessary. The second session consisted of the executive control tasks, which were presented in a fixed order. Participants completed successively the Corsi block tapping task, Go/No-go task, Delay discounting task, Stop signal task and Self-ordered pointing task. The order of the tasks was selected to ensure diversity in task-requirements and to separate two tasks measuring the same construct (i.e., Corsi block tapping task and Self-ordered pointing task; Go/No-go task and Stop signal task). Participants were allowed to take a break between the tasks. After completing the tasks, participants were informed that they would receive a full debriefing after completion of the study. They were thanked for their time and received a gift worth €5 for their participation.

Statistical analyses

IBM SPSS Statistics (Version 19) was used to conduct the statistical analyses. Due to the high number of dependent variables (task parameters) an adjusted alpha level of .01 was used when testing for differences between the groups. The AUC methodology was used for the calculation of delay discounting. AUC was analysed using the Receiver Operating Characteristics (ROC) module. AUC values range from 0 to 1, with values closer to 1 indicating discrepancies in indifference points between the groups in a certain time delay and a value of .50 indicating no discriminative value. Indifference points were not normally distributed for all time delays (Kolmogorov–Smirnov tests showed that indifference points for delays of 1 month and more were normal, while less than 1 month were not) therefore AUC was conducted under the nonparametric assumption.

Results

Group characteristics

Participants were divided into four groups based on IQ and the severity of alcohol use-related problems in the past: light drinking participants with average IQ (n = 10), heavy drinking participants with average IQ (n = 10), light drinking participants with MBID (n = 10) and heavy drinking participants with MBID (n = 10). A one-way between groups analysis of variance was conducted to explore the differences between the four groups (see Table 1). As expected, there were large differences between the groups on est. Total, Verbal and Performance IQ, AUDIT score and weekly alcohol consumption. Post-hoc comparisons using the Tukey HSD test revealed that both heavy and light drinking participants in the Average IQ group had higher est. Total, Verbal and Performance IQs compared to heavy drinking participants with MBID and light drinking participants with MBID. Heavy drinkers in both IQ groups also had a higher AUDIT score and consumed more alcohol per week than light drinkers with average IQ and light drinkers with MBID. The groups did not differ on age, DUDIT score and duration of abstinence.

Group differences

Relationship between IQ and executive control

To test the relationship between IQ and executive control, participants with average IQ and participants with MBID were compared on working memory capacity, inhibitory control and delay discounting using an independent-samples t-test.

Participants with MBID had a smaller working memory capacity compared to participants with average IQ, as indicated by a smaller block span and total score on the Corsi block tapping task (Table 2). The magnitudes of the differences in the means (mean difference = -0.80, 95% CI: -1.38 to -0.22 and mean difference = -16.20, 95% CI: -26.33 to -6.07 respectively) were large (Cohen's d = 0.88 and 1.02 respectively). These differences remained after controlling for AUDIT and DUDIT scores and duration of abstinence in an analysis of covariance ($F(1,35) = 6.10$, $p = .010$, $\eta_p^2 = .15$ and $F(1,35) = 8.52$, $p = .006$, $\eta_p^2 = .20$ respectively). There were no significant differences between the groups on the Self-ordered pointing task.

With regard to inhibitory control, participants with average IQ and participants with MBID did not differ in number of commission errors on the Go/No-go task. Data of two participants on the Stop signal task were removed from analyses due to a disproportionally high error rate (> 75% of the trials). Participants with MBID had a smaller SSRT, indicating they were faster in stopping the prepotent response on a stop-trial compared to participants with average IQ. The magnitude of the differences in the means (mean difference = -149.82, 95% CI: -216.07 to -83.57) was large (Cohen's d = 1.49). After controlling for AUDIT and DUDIT scores and duration of abstinence, this difference remained ($F(1,33)$ = 19.40, $p = < .001$, $\eta_p^2 = .37$). Stop-signal delays, the mean probability of responding on stop-trials and the number of inhibition errors did not differ between groups.

Table 1 Participant characteristics per group (N = 40) :light drinkers with average IQ (n = 10), heavy drinkers with average IQ (n = 10), light drinkers with mild to borderline intellectual disability (MBID; n = 10), and heavy drinkers with MBID (n = 10).

	Average IQ		**MBID**		*F* (3,36)	*p*	η_p^2
	Light drinkers	Heavy drinkers	Light drinkers	Heavy drinkers			
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*			
Age	44.50 (13.29)	42.40 (9.83)	40.60 (13.01)	36.90 (9.84)	0.77	.518	.06
Est. total IQ	97.90 (9.36)	98.30 (10.03)	72.00 (9.38)	72.80 (8.07)	25.81	< .001	.68
Est. verbal IQ	101.80 (9.68)	100.80 (9.10)	67.10 (9.57)	72.30 (9.57)	35.82	< .001	.75
Est. performance IQ	93.50 (13.90)	95.60 (14.13)	77.70 (12.24)	73.50 (7.62)	8.20	< .001	.41
AUDIT score	2.60 (1.84)	22.00 (7.63)	2.90 (2.08)	26.00 (4.81)	68.83	< .001	.71
DUDIT score	11.70 (13.92)	22.70 (12.07)	12.30 (14.70)	16.20 (15.44)	1.29	.293	.04
Weekly alcohol consumption	4.42 (4.45)	160.48 (93.47)	2.41 (3.50)	177.04 (60.44)	29.49	< .001	.85
Number of months abstinent	48.40 (29.80)	48.50 (32.50)	38.40 (19.03)	57.50 (53.81)	0.47	.706	.10

Note. AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001); DUDIT = Drug Use Disorders Identification Test (Berman et al., 2003); η_p^2 = partial eta squared.

Lastly, participants with MBID were compared to individuals with average IQ on delay discounting. Figure 3A depicts a declining pattern for the delay discounting curves of both groups. The 95% CI of the AUC of most indifference points contained the non-discriminatory value .50 indicating poor predictive value between the two groups. As shown in Table 3, only AUC at a delay of 2 days showed a difference (AUC = .29, p = .026), while the AUC at a 2 years delay approached significance (AUC = .32, p = .053). The AUCs were .29 and .32 respectively, which is in the opposite direction of ideal sensitivity and specificity levels. In addition, there were no differences between participants with MBID or average IQ on inconsistency or complexity.

Relationship between severity of alcohol use-related problems and executive control

To test the relationship between severity of alcohol use-related problems and executive control, heavy and light drinkers were compared on working memory capacity, inhibitory control and delay discounting using an independent-samples *t*-test. As shown in Table 2, heavy and light drinking participants did not differ on any of the parameters. These results remained after controlling for est. Total IQ, duration of abstinence and DUDIT score in an analysis of covariance. Performance on the executive control tasks was related to est. Total IQ as indicated by partial eta squared values ranging between .19 to .33 on parameters of the Corsi block tapping task (block span and total score), Self-ordered pointing task (total score and number of errors) and Stop signal task (SSRT). The results of the Delay discounting task are summarised in Table 3. All the AUCs were close to .50, indicating poor predictive value between the two groups. Indeed, there were no significant differences between heavy and light drinkers on delay discounting. Figure 3B further illustrates these results; the delay discounting curves of both groups are very similar.

Relationship between IQ, severity of alcohol use-related problems and executive control

A one-way between-groups analysis of variance was conducted to explore the relationship between IQ, severity of alcohol use-related problems and executive control (i.e., working memory capacity, inhibitory control and delay discounting). Participants were divided into four groups based on severity of alcohol use-related problems and est. Total IQ.

With regard to working memory capacity, there was a difference at the $p < .01$ level in Corsi total score: $F(3,36) = 4.41$, $p = .010$, $\eta_p^2 = .27$). Post-hoc comparisons using the Tukey HSD test indicated that the mean total scores for heavy drinkers with MBID (M = 36.00, SD = 9.68) and light drinkers with MBID (M = 38.10, SD = 14.67) were significantly smaller compared to the score for light drinkers with average IQ (M = 58.80, SD = 18.55). The groups did not differ on block span on the Corsi block tapping task nor on parameters of the Self-ordered pointing task.

There was also a significant difference in SSRT on the Stop signal task ($F(3,34) = 6.67$, $p = .001$, $\eta_p^2 = .37$), which is a measure of inhibitory control. Post-hoc comparisons showed that heavy drinkers with MBID (M = 257.33, SD = 111.84) and light drinkers with MBID

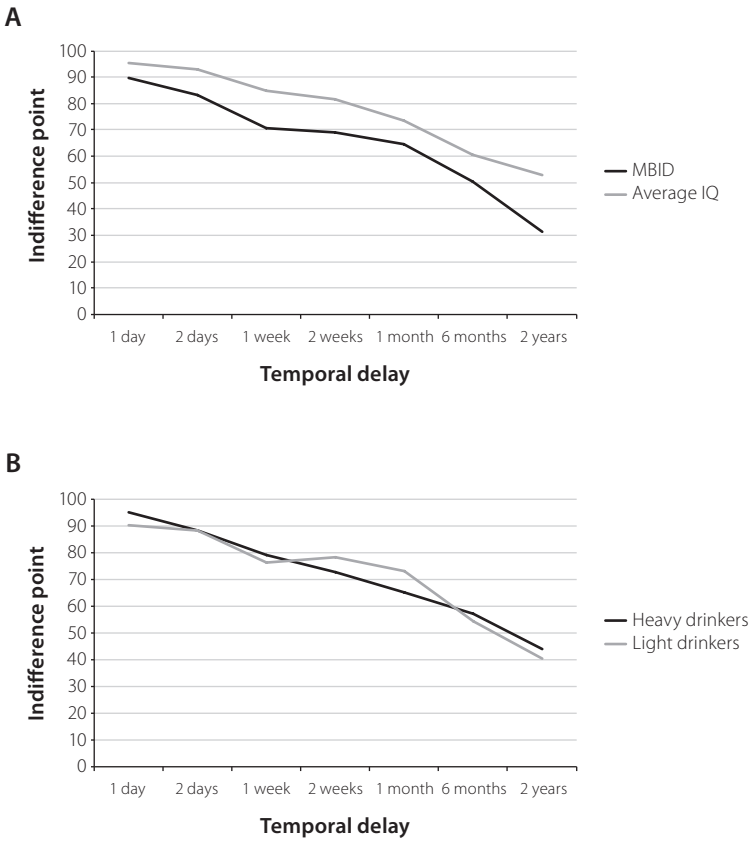

Figure 3 Delay discounting curves per participant group showing the relationship between the value of the immediate reward as a function of the length of delay. (**A**) shows the delay discounting curves of the two groups based on IQ (participants with mild to borderline intellectual disability (MBID) vs. participants with average IQ) and (**B**) represents the two groups based on severity of alcohol use-related problems (heavy vs. light drinkers). (**C**) combines all four participant groups (heavy drinkers with MBID, light drinkers with MBID, heavy drinkers with average IQ, and light drinkers with average IQ).

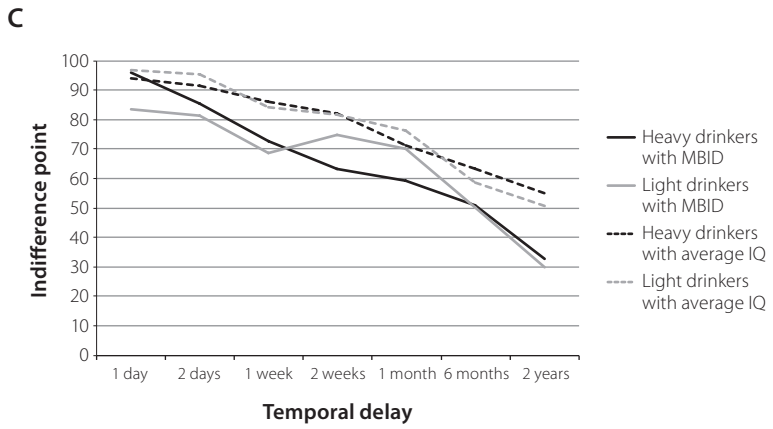

Figure 3 Continued.

(*M* = 254.33, *SD* = 104.98) had a smaller SSRT compared to both heavy drinkers with average IQ (*M* = 412.70, *SD* = 123.254) and light drinkers with average IQ (*M* = 398.60, *SD* = 64.93). This indicates that, overall, participants with MBID were faster in stopping a prepotent response on a stop-trial compared to participants with average IQ.

A one-way between-groups multivariate analysis of variance was performed to investigate group differences in delay discounting. Dependent variables were the indifference points for each of the seven time delays. There were no significant differences between the four groups on the combined dependent variables, $F(3,40) = 1.16$, $p = .306$; Wilks' Lambda = .49; $\eta_p^2 = .21$. As illustrated in Figure 3C, the delay discounting curves of both groups are very similar.

Correlations

The relationship between IQ, severity of alcohol use-related problems and executive control as well as the relationship between the different task parameters was investigated using Pearson product-moment correlation coefficient. As shown in the Appendix, IQ was related to working memory capacity: There were significant correlations between est. Total IQ and block span ($r = .48$, $p = .002$) and total score ($r = .52$, $p = .001$) on the Corsi block tapping and total score ($r = .44$, $p = .005$) and number of errors ($r = -.44$, $p = .005$) on the Self-ordered pointing task. With the exception of SSRT on the Stop signal task ($r = .55$, $p < .001$), parameters of inhibitory control and delay discounting were not related to est. Total IQ. None of the task parameters correlated significantly with measures of severity of alcohol use-related problems. With regard to the correlation between the tasks, there was a medium, positive correlation between performance on the Corsi block tapping task and Self-ordered pointing task ($r = .42$, $p = .007$). The correlations between performance on the Go/No-go task and Stop signal task did not reach statistical significance ($r = .30$, $p = .071$).

Table 2 Participant characteristics per group (N = 40) :light drinkers with average IQ (n = 10), heavy drinkers with average IQ (n = 10), light drinkers with mild to borderline intellectual disability (MBID; n = 10), and heavy drinkers with MBID (n = 10).

	Intelligence quotient							**Severity of alcohol use-related problems**						
	Average IQ		MBID					Light drinkers		Heavy drinkers				
	M (SD)		*M (SD)*		*t*(38)	*p*	Cohen's *d*	*M (SD)*		*M (SD)*		*t*(38)	*p*	Cohen's *d*
Corsi block tapping task														
Block span	5.50	(1.00)	4.70	(0.80)	- 2.79	.008	0.88	5.25	(1.12)	4.95	(0.83)	0.97	.340	0.30
Total score	53.25	(18.80)	37.05	(12.15)	- 3.24	.003	1.02	48.45	(19.43)	41.85	(15.45)	1.19	.242	0.38
Self-ordered pointing task														
SOPT score	115.85	(8.68)	111.10	(7.54)	- 1.85	.072	0.58	113.50	(8.81)	113.45	(8.15)	0.02	.985	0.01
Number of errors	13.15	(8.68)	17.90	(7.58)	1.84	.073	-0.58	15.50	(8.84)	15.55	(8.15)	- 0.02	.985	-0.01
Number of perseverative errors	3.50	(5.74)	2.35	(1.76)	- 0.86	.397	0.27	2.80	(2.31)	3.05	(5.60)	- 0.19	.854	-0.06
Go/No-go task														
Number of commission errors	0.45	(1.00)	0.70	(1.17)	0.73	.473	-0.23	0.45	(0.69)	0.70	(1.38)	- 0.73	.473	-0.23
Stop signal task														
SSRT	405.65	(96.15)	255.83	(105.24)	- 4.59	< .001	1.49	330.26	(111.73)	339.11	(139.67)	- 0.22	.831	-0.07
SSD	335.25	(14.51)	331.89	(45.35)	- 0.31	.755	0.10	330.21	(43.98)	337.11	(14.51)	- 0.65	.521	-0.21
Mean *p*	15.70	(11.02)	13.22	(21.98)	- 0.45	.658	0.14	16.42	(21.52)	12.63	(10.81)	0.69	.497	0.22
Number of inhibition errors	7.90	(5.56)	6.61	(10.99)	- 0.46	.646	0.15	8.26	(10.79)	6.32	(5.41)	0.70	.486	0.23
Delay discounting task														
Inconsistency score	0.90	(1.86)	2.60	(2.50)	2.44	.020	-0.77	1.70	(2.47)	1.80	(2.26)	- 0.13	.895	-0.04
Complexity score	3.30	(2.25)	2.85	(2.06)	- 0.66	.513	0.21	3.40	(2.01)	2.75	(2.27)	0.96	.344	0.30

Note. SOPT = self-ordered pointing task; SSRT = stop signal reaction time; SSD = stop signal delay.

Table 3 Descriptive statistics and AUC of indifference points for tested time delays on the delay discounting task per participant group (heavy and light drinking participants, with average IQ or mild to borderline intellectual disability [MBID]).

	Intelligence quotient				**Severity of alcohol use-related problems**			
	Average IQ	MBID			Light drinkers	Heavy drinkers		
	M (SD)	*M (SD)*	AUC	*p*	*M (SD)*	*M (SD)*	AUC	*p*
One day delay	95.55 (3.41)	89.88 (20.79)	.57	.465	90.30 (20.76)	95.13 (4.18)	.46	.636
Two days delay	93.25 (7.33)	83.28 (14.83)	.29	.026	88.23 (13.37)	88.30 (12.13)	.48	.818
One week delay	85.06 (18.48)	70.64 (26.07)	.36	.133	76.36 (24.61)	79.34 (22.81)	.55	.570
Two weeks delay	81.90 (17.73)	69.18 (31.55)	.42	.409	78.30 (23.48)	72.78 (28.76)	.43	.473
One month delay	73.74 (27.47)	65.59 (35.97)	.46	.646	73.13 (30.80)	65.21 (33.33)	.40	.279
Six months delay	60.79 (27.80)	50.56 (36.64)	.44	.525	54.28 (33.57)	57.07 (32.24)	.52	.860
Two years delay	52.99 (33.51)	31.44 (34.11)	.32	.053	40.43 (36.35)	44.00 (34.67)	.54	.655

Note. AUC = Area under the curve.

Discussion

The goal of the present study was to test the relationship between executive control (i.e., working memory capacity, inhibitory control and delay discounting), IQ and chronic alcohol use. The first hypothesis was that, on average, individuals with mild to borderline intellectual disability (MBID) would have a smaller working memory capacity, would have poorer inhibitory control and would discount monetary delays faster than individuals with an average IQ (Danielsson et al., 2010; Willner et al., 2010a). As a whole, executive control was not consistently impaired among individuals with MBID compared to individuals with average IQ. Results showed that working memory capacity did seem to be impaired among individuals with MBID, whereas inhibitory control and delay discounting did not. Surprisingly, both groups performed worse on the Delay discounting task (Rachlin et al., 1991) in comparison to findings presented in Madden et al. (2004, p. 254) and Myerson et al. (2001, p. 236) reflecting impulsive decision making (i.e., a fast discount of monetary delays) in both groups. This may be due to the characteristics of the participants in our sample (e.g., undergoing residential treatment, high co-morbidity with other disorders, history of criminal and/or violent behaviour) or task characteristics such as its difficulty and repetitiveness.

The second hypothesis was that former heavy alcohol drinkers would perform worse on the executive control tasks than former light drinkers, meaning they would have a smaller working memory capacity, poorer inhibitory control and would discount monetary delays faster compared to light drinkers (e.g., Fein et al., 2004; Petry, 2001). Contrary to the expectations, heavy drinkers performed equally well on all measures of working memory capacity, inhibitory control and delay discounting. Although this is in contrast with some earlier research indicating executive dysfunction in abstinent alcoholics, the association between severity of alcohol use-related problems and deficiencies in executive control has not been uniformly found in previous research (e.g., Fernie, Cole, Goudie, & Field, 2010; MacKillop, Mattson, MacKillop, Castelda, & Donovick, 2007). It has therefore been suggested that alcohol-related cognitive impairment decreases over time after cessation of drinking (e.g., Fein, Torres, Price, & Di Sclafani, 2006; Loeber et al., 2009a). As the participants in our study had been abstinent for roughly 3–4 years at the time of testing, it is possible that cognitive impairments as a result of alcohol use have faded over the years.

The third hypothesis was that the combination of MBID and a history of alcohol use-related problems would have an additive effect on executive control and that these participants would therefore perform worse on the executive control tasks compared to the other participants. Our results did not support this hypothesis. A dual diagnosis of MBID and alcohol use-related problems did not seem to impair executive control further compared to having either one of those diagnoses alone. This implies that individuals with MBID and alcohol use-related problems are not more vulnerable compared to other

problematic alcohol users. However, as described earlier, it is also possible that the alcohol-related cognitive impairment has faded over the years and that there are additive effects of the dual diagnosis of MBID and alcohol-use related problems on the short term.

Lastly, intercorrelations between performance on the five executive control tasks were studied. Performance on the Corsi block tapping task (Corsi, 1972) correlated positively with performance on the Self-ordered pointing task (Petrides & Milner, 1982). This is in line with the expectations, as both tasks measure working memory capacity (Park & Payer, 2006). Performance on the Go/No-go task (Newman & Kosson, 1986) and Stop signal task (Logan et al., 1984) was not significantly correlated. This is surprising as previous research has found performance on both tasks to be significantly, albeit weakly, correlated (Fernie et al., 2010; Reynolds et al., 2006). Although both are measures of inhibitory control, the tasks differ in one important aspect. According to the current literature, two different forms of inhibition can be distinguished that reflect different neural processes in the brain, namely action restraint and action cancelation (Schachar et al., 2007). Action restraint refers to refraining from a response before that response has been initiated. This form of inhibition is often studied using the Go/No-go task. Action cancelation, on the other hand, refers to overriding a motor response during its execution, such as measured by the Stop signal task. One explanation for the results might therefore be that, although very similar, the Go/No- go task and Stop signal task do in fact tap into different aspects of inhibitory control.

We note two limitations of our study. First, our sample size was small and statistical power was limited. It is therefore warranted to replicate this study using a larger sample size. Second, because of the cross-sectional nature of our study it is not possible to draw conclusions on the direction of the relationship between IQ, severity of alcohol use-related problems and executive control. Previous research has suggested that deficient executive control could be a vulnerability marker for developing alcohol use-related problems (Verdejo-García et al., 2008) as well as a consequence of chronic alcohol use (e.g., Grenard et al., 2008; Li et al., 2009;MacKillop et al., 2011). To examine the nature of the relationship between alcohol use and executive dysfunction in more detail and to investigate the time course of recovery of executive dysfunction after cessation, it is advised to follow-up participants for a longer period of time using a prospective design. In addition, it is advised to include current drinkers in the study as opposed to the participants in our study, who were all detoxified and (long-term) abstinent at the time of testing. A better understanding of the role of executive control and cognitive dysfunction in addiction may guide treatment possibilities. For example, if abstinent alcoholics respond more impulsively, treatments concentrating on the long-term consequences of cessation (e.g., improvements of physical and mental health) might not be effective (Petry, 2001). Also, there is some evidence that cognitive control can be modified or improved through training procedures (Erickson et al., 2007; Klingberg et al., 2005; Olesen, Westerberg, & Klingberg, 2004), which provides new lines of inquiry and new treatment directions.

Therefore, more research is needed to investigate both the role of executive control in the development and maintenance of alcohol use-related problems and the potential influence of IQ on this relationship.

An important implication of our study is that the executive control tasks used in this study are applicable in individuals with MBID. As research on executive control in these individuals is scarce and results of previous studies are mixed (see Willner et al., 2010a), this finding is useful for future research on this topic. In a post hoc evaluation of this study, participants rated the tasks overall as easy to conduct. However, participants with MBID experienced difficulties in conducting the Self-ordered pointing task (Petrides & Milner, 1982) and the Stop signal task (Logan et al., 1984). The Self-ordered pointing task requires the participant to complete the entire task despite the number of errors made, which could lead to frustration and loss of confidence in one's own performance. It is preferable to use the Corsi block tapping task (Corsi, 1972) instead of the Self-ordered pointing task to measure working memory capacity because of the 'stop rule' of the Corsi block tapping task: the task ends when the participant fails to reproduce two sequences of equal length, leaving the participant thinking he or she completed the entire task without much difficulty. The Stop signal task requires "multi-tasking": the participant needs to watch the screen, process the cue presented on the screen, press a corresponding button and listen for the stop signal simultaneously while keeping the instructions of the task in mind. As the Go/No-go task (Newman & Kosson, 1986) consists of fewer elements and is therefore easier, researchers might want to choose this task instead of the Stop signal task in future studies on inhibitory control.

To conclude, the executive control tasks used in this study are applicable in individuals with MBID, but researchers should take into consideration the possible difficulties with performing the Self-ordered pointing task (Petrides & Milner, 1982) and Stop signal task (Logan et al., 1984). The results of our pilot study suggest that executive control is not uniformly impaired in individuals with MBID. Some components of executive control might be weaker in these individuals than other components. Second, results showed no differences between heavy and light former drinkers on any of the executive control tasks. Third, there does not seem to be an additive effect of having a dual diagnosis of MBID and alcohol use-related problems. This implies that these individuals are not more vulnerable compared to other problematic alcohol drinkers. Taking these results together it is suggested that alcohol-related cognitive impairment is temporary and decreases over time after cessation of drinking.

Appendix Correlation Matrix for Indices of IQ (Estimated Total, Verbal, and Performance IQ), Severity of Alcohol Use-Related Problems (AUDIT score, Weekly Alcohol Consumption, and Duration of Abstinence), and Performance on Five Executive Control Tasks.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Est. Total IQ	–																	
2	Est. Verbal IQ	.93*	–																
3	Est. Performance IQ	.88*	.66*	–															
4	AUDIT score	-.07	-.05	-.15	–														
5	Weekly alcohol consumption	.00	.03	-.14	.92*	–													
6	Duration of abstinence	-.00	.01	-.03	.21	.16	–												
7	Corsi – Block span	.48*	.35	.49*	-.25	-.21	.01	–											
8	Corsi – Total score	.52*	.39	.54*	-.29	-.23	-.01	.97*	–										
9	SOPT – Total score	.44*	.41	.31	-.16	-.12	-.11	.48*	.42*	–									
10	SOPT – Number of errors	-.44*	-.41*	-.32	-.16	-.12	-.10	-.48*	-.42*	-1.00*	–								
11	SOPT – Perseverative errors	-.04	-.06	-.03	.09	.12	-.15	-.13	-.11	-.67*	.67*	–							
12	GNG – Commission errors	-.06	-.08	-.09	.25	.32	.03	-.22	-.25	-.10	.10	.11	–						
13	SST – SSRT	.55*	.57*	.45*	-.05	-.14	.01	.08	.09	.25	-.25	.01	.27	–					
14	SST – SSD	.14	.15	.08	.11	.12	.07	-.13	-.05	.06	-.06	-.07	-.23	.22	–				
15	SST – Mean *p*	-.02	-.03	.04	-.11	-.10	-.05	.12	.07	-.15	.15	.17	.30	-.19	-.95*	–			
16	SST – Inhibition errors	-.02	-.03	.04	-.11	-.10	-.05	.12	.07	-.15	.15	.17	.30	-.19	-.95*	1.00*	–		
17	DDT – Complexity score	.10	-.03	.11	-.16	-.18	-.05	.06	.04	-.14	.14	.10	-.25	.27	.06	-.05	-.05	–	
18	DDT – Inconsistency score	-.33	-.40	-.31	.11	.03	-.01	-.36	-.37	-.13	.13	-.03	-.19	.39*	-.28	-.05	.01	.01	–

Note. AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001); Corsi = Corsi block tapping test (Corsi, 1972); SOPT = Self-ordered pointing task (Petrides & Milner, 1982); GNG = Go/No-go task (Newman & Kosson, 1986); SST = Stop signal task (Logan et al., 1984); SSRT = stop signal reaction time; SSD = stop signal delay; DDT = Delay discounting task (Rachlin et al., 1991). * $p < .01$

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Executive control and motivation in problematic drinkers with mild to borderline intellectual disability

This chapter has been submitted as:
Van Duijvenbode, N., Didden, R., Korzilius, H. P. M. L., & Engels, R. C. M. E. (submitted). *Does it take two to tango? The role of executive control and readiness to change in problematic drinkers with mild to borderline intellectual disability.*

Abstract

The goal of the study was to explore the moderating role of executive control and readiness to change on the relationship between alcohol use and cognitive biases. Participants performed the visual dot probe task to measure the strength of the cognitive biases. Executive control was measured using two computerised tasks for working memory capacity (Corsi block tapping task) and inhibitory control (Go/No-go task). Readiness to change was measured using the Readiness to Change Questionnaire. No cognitive biases or executive dysfunctions were found in problematic drinkers. Working memory capacity and inhibitory control were impaired among individuals with MBID, irrespective of severity of alcohol use-related problems. Executive control and readiness to change did not moderate the relationship between alcohol use and cognitive biases. The results fail to support the dual process models of addiction. Implementing a neurocognitive assessment and protocols in the treatment of substance use disorders seems premature.

Introduction

Problematic alcohol use is associated with a wide range of adverse consequences. For example, it is related to more than 60 different medical conditions, can cause serious intentional and unintentional injuries and is responsible for 2.74 million deaths annually, being the fifth leading risk factor for global diseases in 2010 (Lim et al., 2012; Room, Babor, & Rehm, 2005). In individuals with a mild to borderline intellectual disability (MBID; IQ 50–85, American Psychological Association [APA], 2013), alcohol use-related somatic, psychological and social problems might be even more prevalent and more severe (Slayter, 2008). For example, the simultaneous use of prescribed, psychotropic medication (e.g., antiepileptics) can alter the effects of these medications and can possibly lead to health problems (Taggart, McLaughlin, Quinn, & Milligan, 2006). Moreover, problematic alcohol use is related to problems with work, housing and the social network of individuals with MBID (Slayter, 2008) and is a risk factor for emotional and behavioural problems (Didden, Embregts, Van der Toorn, & Laarhoven, 2009) and delinquency (McGillivray & Moore, 2001).

Problematic alcohol use also has several neuropsychological consequences. Research in individuals without MBID indicates that problematic alcohol use affects the motivational, reward and inhibitory control systems of the brain (Koob, 2013; Volkow, Wang, Tomasi, & Baler, 2013). For example, chronic and/or excessive alcohol use leads to a disrupted inhibitory control system, which is reflected in a smaller working memory capacity, difficulties in delaying gratification and less behavioural control in problematic drinkers (Koob, 2013). Problematic alcohol use also leads to a hypersensitive limbic system, leading the rewarding effects of alcohol and alcohol-related stimuli to become overvalued at the expense of other rewards (Hyman, Malenka, & Nestler, 2006; Nestler, 2005). Robinson and Berridge (2008) have called this 'incentive salience' or cognitive biases, meaning alcohol-related stimuli seem attractive, capture attention and elicit approach behaviour. These processes are considered to be spontaneous and fast and can sometimes occur outside of conscious awareness (Bechara, Noel, & Crone, 2006; Strack & Deutsch, 2004).

According to dual process models of addiction (e.g., Bechara et al., 2006; Strack & Deutsch, 2004), the influence of these cognitive biases on behaviour can be suppressed if there are sufficient motivation and cognitive resources to do so (Fazio & Olson, 2003). According to Stacy, Ames and Knowlton (2004) and Wiers and Stacy (2006), individuals with strong executive control (EC) might be more able to 1) maintain long-term (personal) goals in active memory; 2) suppress the influence of impulses conflicting with those goals; and 3) apply several strategies to resolve the goal conflict than individuals with weak EC. Indeed, several studies in non-clinical populations show that EC moderates the relationship between cognitive biases and drinking behaviour (e.g., Burton, Pedersen, & McCarthy, 2012; Grenard et al., 2008; Loeber et al., 2009b; Peeters et al., 2012; Thush et al., 2008; but see Pieters, Burk, Van der Vorst, Engels, & Wiers, 2014; Pieters, Burk, Van der Vorst,

Wiers, & Engels, 2012; Van Hemel-Ruiter, De Jong, & Wiers, 2011 for contrasting results). In addition to the ability to inhibit automatic processes, one must also be motivated or ready to change behaviour. Although its relationship with automatic information processing has not been studied yet, readiness to change is a strong predictor of treatment outcome (Adamson, Sellman, & Frampton, 2009; Laudet & Stanick, 2010) and is therefore often targeted in addiction interventions (Austin, Hospital, Wagner, & Morris, 2010).

Following this line of reasoning, the behaviour of individuals with weak EC, including those with MBID (Willner, Bailey, Parry, & Dymon, 2010a), might be strongly influenced by fast and automatic processes. This then provides implications for treatment. For example, concentrating on the long-term positive consequences of cessation might not be effective in individuals with weak EC, as these treatment goals will be overruled easily when confronted with the positive, short-term consequences of alcohol use. Also, individuals with weak EC might benefit from treatment interventions that strengthen the capacity and willingness to inhibit these automatic processes, for example in working memory training (Houben, Wiers, & Jansen, 2011) or by using motivational interviewing methods (Rubak, Sandbæk, Lauritzen, & Christensen, 2005). Both working memory

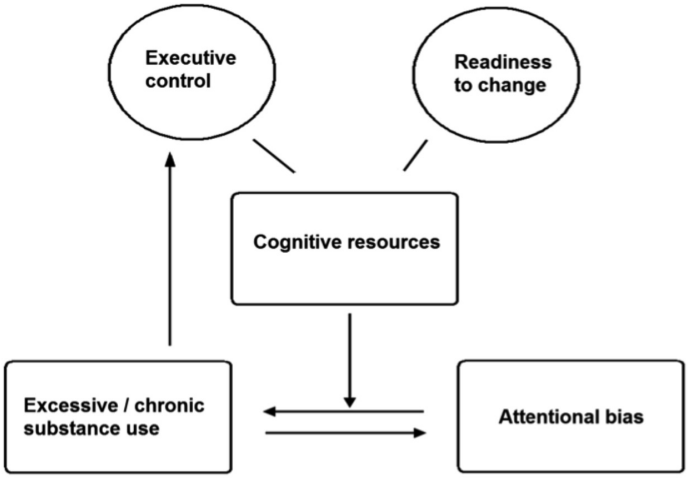

Figure 1 Schematic overview of the conceptual model (adapted from Houben, Schoenmakers, Thush, & Wiers, 2008). According to this model, excessive and/or chronic substance use leads to cognitive biases (e.g., attention), maintaining the substance use (disorder) as a result. The influence of the cognitive biases on substance use behaviour can be suppressed by cognitive resources, consisting of both executive control (e.g., working memory capacity and inhibitory control) and motivation or readiness to change. However, excessive and/or chronic substance use weakens the level of executive control, making it more difficult for problematic substance users to control their behaviour.

training and motivational interviewing methods have been shown to also be feasible and effective for use in individuals with MBID (Kerr, Lawrence, Darbyshire, Middleton, & Fitzsimmons, 2013; Van der Molen, Van Luit, Van der Molen, Klugkist, & Jongmans, 2010).

The primary goal of the present study therefore was to explore the moderating effect of EC and readiness to change on the relationship between alcohol use and attentional processes (see Figure 1 for our conceptual model). We have included light and problematic drinkers with and without MBID to study both the role of severity of alcohol use-related problems as well as IQ. First, we hypothesised that, irrespective of IQ, problematic drinkers would show a stronger attentional bias towards alcohol-related stimuli than light drinkers. Second, we hypothesised that individuals with MBID would show a significantly weaker EC (e.g., working memory capacity and inhibitory control) than individuals without MBID. Similarly, we hypothesised problematic drinkers to show a smaller working memory capacity and have poorer inhibitory control compared to light drinkers. We expected that the combination of MBID and problematic alcohol use would have an additive effect on EC and that these participants would therefore perform worse on the EC tasks compared to the other participants. Third and last, we hypothesised that EC and readiness to change would moderate the relationship between the severity of alcohol use-related problems and strength of the attentional bias, such that stronger EC and higher levels of readiness to change would weaken the relationship between the attentional bias and the severity of alcohol-use related problems.

Method

Participants

A total of 112 participants (61 men) took part in this study. Their mean age was 30.9 years (*SD* = 12.3; range = 18–60). Most participants completed primary school (15.2%, *n* = 17), special education (24.1%, *n* = 27) or secondary school (31.3%, *n* = 35). Four (3.6%) participants had no finished education and 33 participants (29.5%) still attended vocational school or university (college). The majority of participants originated from the Netherlands (90.2%, *n* = 101). The other participants originated from Surinam/The Antilles (3.6%, *n* = 4), Morocco/Turkey (1.8%, *n* = 2) or other Western or non-Western countries (4.5%, *n* = 5). All participants spoke Dutch fluently and had normal or corrected to normal vision.

Although half of participants (53.6%, *n* = 60) received outpatient or residential care from organisations within ID care or addiction medicine at the time of the study, they all had access to and/or consumed alcohol in the previous 1.5 months. Forty-two participants (37.5%) were diagnosed with one or more psychiatric disorders. Substance use disorder (27.7%, *n* = 31), autism spectrum disorder (12.5%, *n* = 14) and attention deficit hyperactivity disorder (6.3%, *n* = 7) were diagnosed most often. In addition, 29 participants (25.9%) were prescribed psychotropic medication, including benzodiazepines, antipsychotics and antidepressants.

Material

Substance use

Alcohol use was assessed using the Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q; VanDerNagel, Kiewik, Van Dijk, De Jong, & Didden, 2011b). This is a Dutch-language instrument to assess substance use, risk factors for problematic substance use and consequences of (problematic) substance use in individuals with MBID. It is adapted to the needs of this group by avoiding lengthy or complex phrases, difficult wording and jargon (see VanDerNagel, Kemna, & Didden, 2013). Alcohol use was explored by asking questions about general frequencies and quantities, which was then converted into standard units of 10g of alcohol (International Center for Alcohol Policies, 2010).

Integrated in the SumID-Q is the Alcohol Use Disorder Identification Test (AUDIT; Babor, Higgings-Biddle, Saunders, & Monteiro, 2001; Dutch translation: Schippers & Broekman, 2010). The AUDIT is a standardised questionnaire used to measure the severity of alcohol use-related problems. It consists of 10 questions about the amount, frequency and consequences of alcohol use. Participants answer every question on a 5-point scale ranging from 'never' (0 points) to 'almost every day' (4 points). Total scores range between 0 and 40, with higher scores reflecting more severe alcohol use-related problems. A score of 8 or more is indicative of hazardous alcohol use (Babor et al., 2001) and was used in this study to classify participants as either light drinkers (score < 8) or problematic drinkers (score ≥ 8). The reliability and validity of the AUDIT has found to be good in non-clinical and clinical adult populations (Babor et al., 2001). In the current study, Cronbach's alpha was .88 (mean inter-item correlation = .43).

Attentional bias

The attentional bias was measured using the visual dot probe task (MacLeod, Mathews, & Tata, 1986; for a detailed description of the task adapted to individuals with MBID, see Van Duijvenbode, Didden, Voogd, Korzilius, & Engels, 2012b), which was presented on a 17-inch thin film transistor (TFT) flat screen monitor. The task consisted of one practice block of 30 trials and four test blocks of two buffer trials and 25 critical trials each. The practice and buffer trials consisted of two neutral pictures. In every critical trial, one alcoholic and one non-alcoholic beverage were presented on the left and the right side of the screen. Both pictures were matched for structural content, such as size and colour. After 2000 ms, the pictures disappeared and a dot probe (white dot) appeared on either the left or the right side of the screen (see Figure 2). Participants were instructed to indicate the position of the probe as quickly and accurately as possible by pressing a button on the response box. The dependent variable was the reaction time (RT) in ms to respond to the dot probe on critical trials. Median RTs were used instead of mean RTs to minimise the influence of outliers (Peeters et al., 2012). Using the median RTs, we calculated an attentional bias score by subtracting the RT of trials in which the dot probe replaced the alcoholic beverage from the RT of trials in which the dot probe replaced the non-

alcoholic beverage (RT_{sod} – RT_{alc}). A positive score is indicative of an attentional bias towards alcohol, while a negative score indicates a bias away from alcohol (Loeber et al., 2009b).

The internal consistency of the RTs was excellent, reflected by a Cronbach's alpha of .99 and a mean inter-item correlation of .92. The internal consistency of the attentional bias scores, on the other hand, was poor (Cronbach's alpha = -.23, mean inter-item correlation = .00), indicating poor internal consistency of the bias scores. These results maintained when exploring each participant group (light and problematic drinkers with and without MBID) and trial category (alcohol and soda trials) separately. The problematic psychometric qualities of the VDP have been noted previously (Ataya et al., 2012a; Field & Christiansen, 2012). However, the VDP remains one of the most widely used tasks to measure attentional biases in problematic drinkers (Field & Cox, 2008) and was selected to ensure comparability between our research findings and earlier research findings in problematic drinkers without MBID. Despite the problematic psychometric qualities of the visual dot probe task, results of this task will be further analysed due to the large individual variation in the attentional bias and the potential influence of EC and readiness to change on this variation.

As in our previous study (Van Duijvenbode, Didden, Korzilius, & Engels, 2016b), participants with MBID had a significantly larger overall RT ($t(68.48) = 5.75$, $p < .001$), overall *SD* in RT ($t(80.73) = 4.34$, $p < .001$) and intra-individual coefficient of variation in RT (individual SD_{RT} / individual M_{RT}; $t(106.38) = 2.00$, $p = .049$) compared to participants without MBID.

Figure 2 Schematic overview of the Visual Dot Probe Task (VDP; MacLeod et al., 1986).

Executive control

EC was measured using one task for working memory capacity and one task for inhibitory control, which were both presented in Inquisit software version 3.0.6.0 (Millisecond, 2011) on a 17-inch laptop (see also Van Duijvenbode, Didden, Korzilius, Trentelman, & Engels, 2013).

Working memory capacity was measured with the Corsi block tapping task (Corsi, 1972), in which participants were shown nine blue 30 x 30 mm blocks on a black background. The exact coordinates of the blocks are reported by Kessels, Van Zandvoort, Postma, Kappelle and De Haan (2000). In each trial, a sequence of blocks was highlighted by changing the colour from blue to yellow for 1000 ms. The length of the sequence increased gradually with one added block to the sequence after two trials. The task started with two practice trials, followed by up to 16 trials of two to nine block sequences. Participants were instructed to repeat the sequence in the correct order by clicking on the blocks with a computer mouse. Self-corrections were permitted. The task terminated automatically if the participant failed to produce both sequences of equal length correctly. Following Kessels et al. (2000), the dependent variables were block span (longest sequence to be repeated correctly) and total score (the number of correct trials).

Inhibitory control was measured with the Go/No-go task (Newman & Kosson, 1986). The Go/No-go task consisted of one practice block of 20 trials and four test blocks of 25 critical trials each. In every trial, a fixation point (+) was presented on a blank white screen for 500 ms, followed by an upward or downward (both 50%) pointing arrow (750 mm x 480 mm) surrounded by a 90 mm black outlined ring. To encourage participants to pay attention to the task at hand and to prevent them from anticipating the next target, we used five different stimulus onset asynchronies (SOAs; 100, 200, 300, 400 and 500 ms) which were selected randomly (Fillmore, Rush, & Hays, 2006). The cue was followed by either a green go-target or a red no-go target (ratio 4:1). Participants were instructed to press the space bar as quickly and accurately as possible when presented with a go-target, but to withhold from responding when presented with a no-go target. The target remained on the screen until a response was made or 1250 ms had elapsed. RTs below 200 ms were considered outliers and were excluded from analyses (< 1% of the data). The dependent variable was the number of inhibition errors, or the number of times the participant responded to no-go targets (Fillmore et al., 2006).

Readiness to change

Readiness to change was measured using the Readiness to Change Questionnaire (RCQ; Heather & Rollnick, 1993). This questionnaire consists of 12 statements that correspond with three of the stages of change described by Prochaska and DiClemente (1983): pre-contemplation (i.e., not currently considering changing behaviour), contemplation (i.e., ambivalent about changing behaviour) and action (i.e., actively changing behaviour). The participant is asked to specify their level of agreement or disagreement to each of the

12 statements. To increase the feasibility of this questionnaire in participants with MBID, a 3-point Likert scale (disagree, disagree nor agree, agree) was used instead of the original five-point Likert scale. In addition, a visual aid in the form of a thumb up or down was used to help decision making (Bailey, Willner, & Dymond, 2011). The final stage of readiness to change was identified using the highest score of the three scale scores. In case of a tie, the stage further along the continuum was used to indicate the readiness to change. Defuentes-Merillas, De Jong and Schippers (2002) found the reliability of the questionnaire to be satisfactory in a sample of 246 problematic drinkers within an addiction treatment centre (Cronbach's alpha ranging from .68 to .81, mean inter-item correlation ranging from -.49 to -.57). The overall Cronbach's alpha in the current study was .50 (mean inter-item correlation = .08) and ranged from .50 to .86 (mean inter-item correlation ranging from .08 to .86) for the subscales.

IQ

IQ was measured using the most recent scores on the Dutch version of the Wechsler Adults Intelligence Scale third edition (WAIS-III-NL; Uterwijk, 2000b) in the participants' files. If IQ was unknown, a short version of the WAIS-III was used (n = 57) because of time-related issues and potential participant fatigue (Van Duijvenbode, Didden, Van den Hazel, & Engels, 2016a). The short form consists of four subtests – Vocabulary, Similarities, Block design and Matrix reasoning – and can be administered in approximately 30 minutes. It has an excellent reliability (r = .96) and correlates strongly with the full WAIS-III (r = .89). Van Duijvenbode et al., 2016a conclude that the short form provides a reliable and valid estimate of full scale IQ in individuals with MBID. Full scale IQ was used to identify participants with MBID (IQ < 85) or without MBID (IQ ≥ 85).

Procedure

The selection procedure we followed was similar to that in the study of Van Duijvenbode et al. (2016b). No systematic sampling method was used to select and recruit participants. Participants were recruited from organisations within ID care or addiction medicine, via advertisements on social media, the Radboud University and word of mouth. Participants were excluded if they 1) were younger than 18 years old, 2) had an IQ below 50, 3) were not functioning stably (for example, actively psychotic and/or manic or experiencing detoxification symptoms, as assessed by the treatment team), or 4) if they had a history of problematic alcohol use but were currently abstaining for longer than 1.5 months.

All participants were provided with an information leaflet, which included general background information about the study. It also stated participants could deny participation or withdraw at any time during the study without any consequences for their treatment. They were guaranteed that all information would be processed anonymously and were provided with the contact information of the researcher. This information was provided during recruitment and was repeated before obtaining written informed consent.

During the session, participants first provided general demographic information. Then alcohol and other substance use was assessed using the SumID-Q, including the AUDIT. If necessary, the WAIS-III short form was administered to estimate full scale IQ. Participants then completed three computer tasks: the visual dot probe task, the Corsi block tapping task and the Go/No-go task. In between tasks, participants were allowed to take a break whenever necessary. Finally, participants were thanked for their time and received a gift worth €5 (US $6.50, GBP £3.70) for their participation. The entire session lasted approximately 1 to 1.5 hours.

The study was approved by the Committee of Ethics of the Faculty of Social Sciences, Radboud University, Nijmegen, the Netherlands (ECG2012-1301-003).

Statistical analysis

IBM SPSS Statistics (Version 20) was used to conduct the statistical analyses using pairwise deletion of missing data. The data of the visual dot probe task were analysed using a 2 x 2 mixed design ANOVA, with group (light vs. problematic drinkers) and probe position (probe replacing alcoholic beverage vs. probe replacing non-alcoholic beverage) as the independent variables. A 2 x 2 between-groups ANOVA was conducted to explore the relationship between (est.) full scale IQ, severity of alcohol use-related problems and EC (i.e., working memory capacity and inhibitory control). These analyses were complemented with a two-way ANCOVA, with age and drug use as covariates. Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variances and reliable measurement of the covariate. The moderating role of EC and readiness to change in the relationship between the severity of alcohol-use related problems and the strength of the attention bias was explored using multiple regression analyses. All variables were standardised using *z*-scores before entered into the regression. Because the number of participants in the contemplation phase of the readiness to change model was small ($n = 7$), we aggregated this phase with the pre-contemplation phase. Readiness to change was then converted into a dummy variable, with 0 indicating the (pre-)contemplation phase ($n = 91$) and 1 indicating the action phase ($n = 21$). Interaction variables included EC (i.e., Corsi total score and number of inhibition errors) x severity of alcohol use-related problems (i.e., AUDIT score) and EC x severity of alcohol use-related problems x readiness to change. A power analysis (with G*Power Version 3.1.92) showed that with the number of participants in the sample and the statistical tests used a power of .91 was achieved at a medium effect size ($f = .25$) and α of .05.

Results

Group characteristics

Based on (est.) full scale IQ and AUDIT score, participants were divided into four groups: light drinking participants without MBID (AUDIT score < 8, IQ ≥ 85, n = 31), problematic drinkers without MBID (AUDIT score ≥ 8, IQ ≥ 85, n = 30), light drinkers with MBID (AUDIT score < 8, IQ < 85, n = 24) and problematic drinkers with MBID (AUDIT score ≥ 8, IQ < 85, n = 27). As shown in Table 1, a one-way between groups analysis of variance revealed significant differences between the groups on (est.) full scale IQ, AUDIT score and weekly alcohol consumption. Post-hoc Tukey HSD tests showed that participants with MBID had a significantly lower (est.) full scale, verbal and performance IQ compared to participants without MBID, irrespective of the severity of alcohol use-related problems. Similarly, problematic drinkers had a significantly higher AUDIT score and consumed significantly more standard units alcohol per week than light drinkers, irrespective of (est.) full scale IQ. The light and problematic drinking groups also differed on gender ratio ($c^2(3, N = 112) = 21.40$, $p < .001$), with a larger proportion of women in the light drinking group (29.4%) than in the problematic drinking group (16.0%). This was to be expected considering the gender difference in the prevalence of substance use (disorders) in other studies (Lev-Ran, Le Strat, Imtiaz, Rehm, & Le Foll, 2013; Seedat et al., 2009). Groups did not differ on cultural background and age ($ps > .05$).

Cognitive biases

To test our first hypothesis that problematic drinkers would show an attentional bias towards alcohol-related stimuli, the data of the visual dot probe task were analysed using a 2 x 2 mixed design ANOVA. Neither the main effect for probe position ($F(1,107) = 0.15$, $p = .697$) nor the probe position x group interaction ($F(1,107) = 0.06$, $p = .809$) reached statistical significance, meaning there was no attentional bias towards alcohol-related stimuli in problematic drinkers. These results maintained after controlling for (est.) full scale IQ and gender ($F(1,97) = 0.03$, $p = .858$) in a one-way between-groups analysis of covariance. Results of a one-sample t-test confirmed that the bias scores for both light (M = -0.31, SD = 20.30, $t(51) = -0.11$, $p = .91$) and problematic drinkers (M = -0.97, SD = 22.66, $t(56) = -0.32$, $p = .75$) did not differ significantly from zero. There was also no significant difference in bias scores between the two groups ($t(107) = 0.16$, $p = .87$).

Executive control

To test our second hypothesis that (est.) full scale IQ and severity of alcohol use-related problems would have a negative effect on EC, the data of the Corsi block tapping task and Go/No-go task were analysed using a 2 x 2 between-groups analysis of variance.

With regard to working memory capacity, neither the interaction between (est.) full scale IQ and severity of alcohol use-related problems nor the main effect for severity of

Table 1 Participant Characteristics per Group (N = 178): Light Drinkers without Mild to Borderline Intellectual Disability (MBID; n = 40), Problematic Drinkers without MBID (n = 43), Light Drinkers with MBID (n = 41), and Problematic Drinkers with MBID (n = 54).

		Without MBID		**With MBID**		*F* (3,108)	*p*	η_p^2
		Light drinkers	Problematic drinkers	Light drinkers	Problematic drinkers			
	Range	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*			
Age	18 – 60	27.19 (11.10)	29.23 (11.51)	33.29 (11.32)	35.04 (14.07)	2.55	.059	.07
Est. full scale IQ	53 – 120	102.97 (8.98)	102.38 (8.74)	70.46 (7.89)	67.96 (8.41)	131.85	< .001	.80
Est. verbal IQ	49 – 118	100.90 (9.05)	98.27 (8.65)	70.55 (8.32)	70.45 (9.50)	89.65	< .001	.74
Est. performance IQ	49 – 118	105.35 (12.10)	106.85 (12.05)	73.77 (10.81)	69.64 (9.43)	77.24	< .001	.71
AUDIT score	0 – 30	4.45 (2.08)	14.97 (5.93)	3.29 (2.44)	17.85 (6.06)	71.26	< .001	.66
Weekly alcohol consumption	0 – 403	3.57 (3.95)	41.57 (76.70)	1.64 (2.65)	51.00 (58.51)	7.45	< .001	.17

Note. AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001); η_p^2 = partial eta squared.

alcohol use-related problems were statistically significant ($p > .05$). There was a statistically significant main effect for (est.) full scale IQ on block span ($F(1,108) = 29.61$, $p < .001$, $\eta_p^2 = .22$) and total score ($F(1,108) = 33.79$, $p < .001$, $\eta_p^2 = .24$). Post-hoc comparisons using the Tukey HSD test indicated that the mean block span and total score of participants with MBID were significantly lower than that of participants without MBID, irrespective of severity of alcohol use-related problems (see Figure 3a and b). These results maintained after controlling for gender, age and drug use (block span: $F(1,104) = 14.97$, $p < .001$, $\eta_p^2 = .23$; total score: $F(1,99) = 11.39$, $p < .001$, $\eta_p^2 = .19$).

With regard to inhibitory control, the interaction between (est.) full scale IQ and severity of alcohol use-related problems and the main effect for severity of alcohol use-related problems were not significant either ($p > .05$). The main effect for (est.) full scale IQ on inhibition errors did reach statistical significance ($F(1,108) = 6.61$, $p = .012$, $\eta_p^2 = .06$). A post-hoc Tukey HSD test indicated that the number of inhibition errors of participants with MBID was significantly higher than that of participants without MBID, irrespective of severity of alcohol use-related problems (see Figure 3c). These results maintained after controlling for gender, age and drug use ($F(1,99) = 3.89$, $p = .021$, $\eta_p^2 = .07$).

Moderating role of executive control and readiness to change

To test our third and final hypothesis that EC and readiness to change would moderate the relationship between severity of alcohol use-related problems and the strength of the attentional bias, multiple regression analyses were used. Pearson *r* correlations showed that none of the variables correlated significantly with the attentional bias score ($p > .05$). These results were confirmed by multiple regression analyses to assess the ability of severity of alcohol use-related problems, working memory capacity and readiness to change to predict the attentional bias score. The full model was not statistically significant ($F(6,102) = 0.62$, $p = .717$) and explained 18.7% of the variance. Similarly, the full model for the attentional bias score using inhibitory control as a predictor did not reach statistical significance either ($F(6,102) = 0.72$, $p = .635$) and explained 20.1% of the variance. None of the variables predicted the strength of the attentional bias score significantly, nor did the interaction between the variables (β ranging between 0.01 and 0.48, $p > .05$), indicating there was no moderating effect of EC and readiness to change on the relationship between the severity of alcohol use-related problems and the attentional bias.

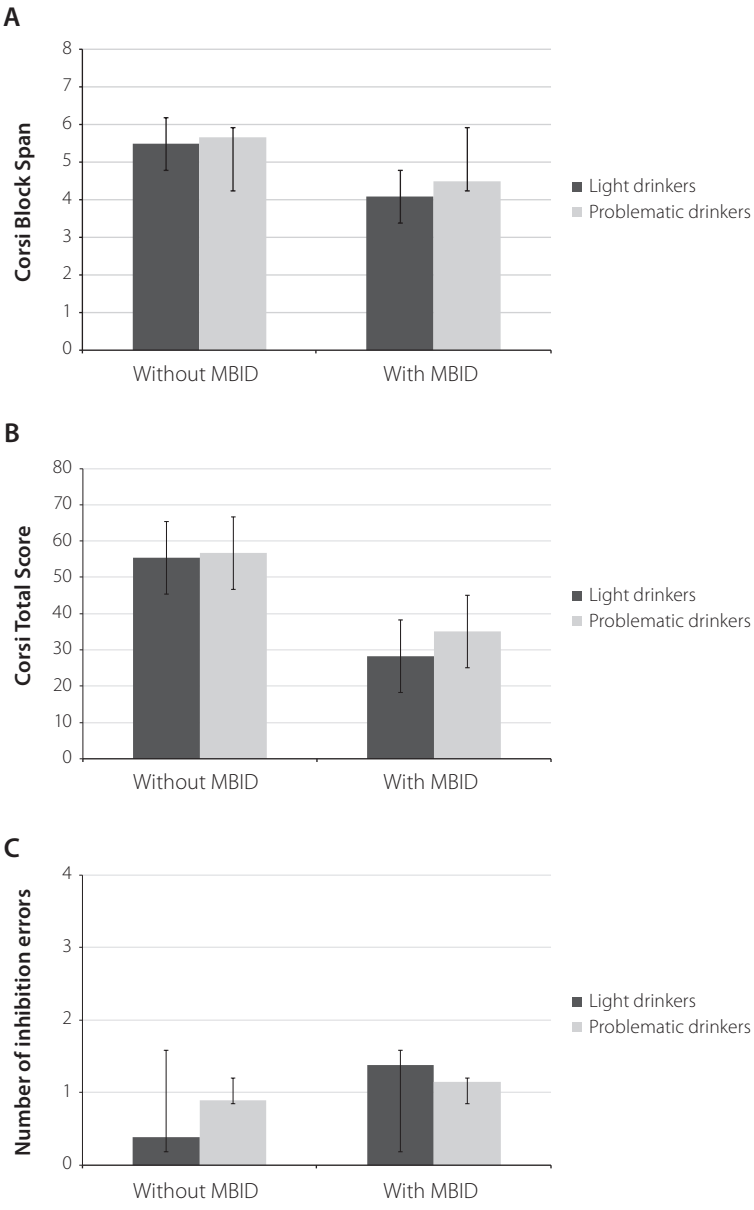

Figure 3 Mean block span (**A**) and total score (**B**) on the Corsi block tapping task (Corsi, 1972) and mean number of inhibition errors (**C**) on the Go/No-go task (Newman & Kosson, 1986) for light and problematic drinkers with and without mild to borderline intellectual disability (MBID).

Discussion

Problematic alcohol use is associated with biases in attention. According to dual process models of addiction (Bechara et al., 2006; Strack & Deutsch, 2004), the influence of this bias on behaviour can be inhibited if there are sufficient motivation and cognitive resources to do so (Fazio & Olson, 2003). The primary goal of the present study was to explore this moderating effect of EC and readiness to change on the relationship between alcohol use and attentional processes in light and problematic drinkers with and without MBID.

Our first hypothesis was that problematic drinkers would show an attentional bias towards alcohol-related stimuli whereas light drinkers would not. As in a study in a different Dutch sample (Van Duijvenbode et al., 2016b) we found no evidence of an attentional bias towards alcohol in problematic drinkers. Overall, both light and problematic drinkers showed a negative mean bias score, indicating an attentional bias *away from* alcohol – a result that has previously been found in problematic drinkers receiving treatment (e.g., Noel et al., 2006; Townshend & Duka, 2007; Van Duijvenbode et al., 2012b; Vollstädt-Klein, Loeber, Von der Goltz, Mann, & Kiefer, 2009). One explanation of these results lies in the diversity of the group of problematic drinkers. As has been concluded before, substance use disorders are complex disorders that are often associated with co-morbid physical and psychiatric problems (Van Duijvenbode et al., 2015). To illustrate, a large majority of the problematic drinkers included in this study was diagnosed with one or more co-morbid psychiatric disorders, were often known with poly-substance use and misuse and were likely to use prescribed, psychotropic medication. All these factors influence information processing and consequently may have influenced our results, although the precise mechanisms of these pathways are difficult to disentangle. A second explanation lies in the problematic psychometric qualities of the visual dot probe task (MacLeod et al., 1986). In line with results of Ataya et al. (2012a, 2012b) and Field and Christiansen (2012), we found the internal consistency of the attentional bias score to be poor. In individuals with MBID, this is complicated further by a large intra-individual, trial-to-trial variability in RT, associated with a difficulty to maintain an optimal level of performance and momentary fluctuations in attention (cf. Baumeister & Kellas, 1968). The implications of this variability in RT on the validity of RT measures in this target group remain unclear.

Our second hypothesis was that individuals with MBID would show a significantly weaker EC than individuals without MBID. Similarly, we hypothesised problematic drinkers to show a smaller working memory capacity and have poorer inhibitory control than light drinkers. The results of this study partially supported this hypothesis. Contrary to the expectations, we found no executive dysfunctioning in problematic drinkers. Although this is in contrast with some other studies, the results of previous research have been mixed and a negative effect of problematic alcohol use on EC has not uniformly been found (e.g., Ellingson, Flemming, Verges, Barthowos, & Sher, 2014; Fernie, Cole, Goudie, &

Field, 2010; MacKillop, Mattson, MacKillop, Castelda, & Donovick, 2007). One explanation for these mixed results is the lack of uniformity in choice of measures for both working memory capacity and inhibitory control and differences between studies on terminology (e.g., substance use, misuse, abuse, disorder) and target group, making it difficult to compare the results of these studies. In line with previous research (e.g., Bexkens, Ruzzano, Collot d'Escury-Koenigs, Van der Molen, & Huizenga, 2014; Danielsson, Henry, Rönnberg, & Nilsson, 2010; Willner et al., 2010a), we did find EC to be impaired among individuals with MBID. Noteworthy is that we found no additive effect of MBID and problematic alcohol use on EC, indicating that problematic alcohol use in individuals with MBID did not impair EC further. Individuals with MBID have a smaller working memory capacity, which means they can hold less information in mind while mentally processing or manipulating it. They also show a weaker inhibitory control, indicating they have more difficulty controlling their behaviour and are more likely to act on impulses. According to Diamond (2013), working memory capacity and inhibitory control are both crucial in day to day life as they enable us to hold goals in mind and act according to those goals. Our results therefore suggest that individuals with MBID might benefit from treatment procedures aimed at increasing EC.

Our third and last hypothesis was that EC and readiness to change would moderate the relationship between the severity of alcohol use-related problems and strength of the attentional bias. According to dual process models of addiction (e.g., Bechara et al., 2006; Strack & Deutsch, 2004), behaviour is influenced by both automatic and controlled processes. The influence of automatic processes (including attention selection and allocation) on drinking behaviour can be suppressed if there are sufficient motivation and cognitive resources to do so (Fazio & Olson, 2003). Our data do not support this hypothesis: EC and readiness to change did not moderate the relationship between the attentional bias and severity of alcohol use-related problems. Although our results are in sharp contrast with previous research (e.g., Burton et al., 2012; Grenard et al., 2008; Loeber et al., 2009b; Peeters et al., 2012; Thush et al., 2008), the moderating role of EC has been questioned before in research on problematic alcohol use in adolescents (e.g., Pieters et al., 2012, 2014; Van Hemel-Ruiter et al., 2011) and the moderating role of readiness to change has not been studied before. The limited overlap in group characteristics between the studies (e.g., adolescents vs. adults, problematic drinkers vs. participants with alcohol use disorder) and tasks used to measure both automatic processes and EC might explain these contrasting results.

We note several limitations of this study. First, there is no golden standard for assessing alcohol use and the severity of alcohol use-related problems in individuals with MBID. In this study, we have opted to use a self-report measure. Although the SumID-Q (VanDerNagel et al., 2011b) is adapted to the needs of those with MBID, the use of self-report measures – especially in this population – can be questioned, for example due to memory-related problems often associated with MBID (Lifshitz, Shtein, Weiss, & Vakil,

2011). Related to this, the validity and reliability of the AUDIT (Babor et al., 2001) in individuals with MBID should be studied in future research. Second, EC was measured using computerised tasks for working memory capacity and inhibitory control. However, EC is more complex and also includes other functions, such as cognitive flexibility, problem solving, reasoning and planning. It is therefore suggested that future research explores the effects of problematic alcohol use on a broader range of executive functions and using different measures. Third, the psychometric qualities of the visual dot probe task are problematic (see also Fernie et al., 2013; Janssen, Larsen, Vollebergh, & Wiers, 2015). The usefulness of this measure is therefore questionable and needs to be examined further. Research should be especially be directed at improving the validity and reliability of implicit measures, for example by using eye tracking methodology and using individualised stimuli based on drinking preferences (Ataya et al., 2012a; Field & Christiansen, 2012; Price et al., 2015).

To conclude, we found no evidence of an attentional bias and executive dysfunction in problematic drinkers. EC (i.e., working memory capacity and behavioural inhibition) and readiness to change also did not moderate the relationship between the strength of the attentional bias and the severity of alcohol use-related problems. However, considering the problematic psychometric qualities of the visual dot probe task, these results need to be treated with caution. Future studies are needed to replicate the results, taking into consideration the limitations of this study. Although individuals with MBID showed a smaller working memory capacity and poorer inhibitory control, there does not seem to be an additive effect of MBID and problematic alcohol use on EC. We therefore recommend clinicians to take into account the deficiencies in EC found in individuals with MBID in day to day care and treatment. For example, considering the low working memory capacity and weak inhibitory control we found in individuals with MBID, clinicians are advised to set concrete, short-term treatment goals rather than abstract, long-term treatment goals as the latter will be overruled easily (Diamond, 2013). Similarly, individuals with MBID – irrespective of severity of alcohol use-related problems – might benefit from treatment interventions aimed at improving EC. One example of such treatment intervention is working memory training, which has been found feasible and effective in individuals with MBID (Van der Molen et al., 2010). Based on our results and the mixed results found in previous research, implementing a neurocognitive assessment and treatment interventions aimed at these consequences might not be useful in the treatment of alcohol use disorders at this stage.

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A tetrad WAIS-III short form for use in individuals with mild to borderline intellectual disability

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Abstract

The goal of the present study was to investigate the reliability and validity of a Wechsler Abbreviated Scale of Intelligence-based Wechsler Adult Intelligence Scale – third edition (WAIS-III) short form (SF) in a sample of individuals with mild to borderline intellectual disability (MBID; N = 117; M_{IQ} = 71.34, SD_{IQ} = 8.00, range = 52–85). A full WAIS-III was administered as a standard procedure in the diagnostic process. The results indicate an excellent reliability (r = 0.96) and a strong, positive correlation with the full WAIS-III (r = 0.89). The SF correctly identified ID in general and the correct IQ category more specifically in the majority of cases (97.4% and 86.3% of cases, respectively). In addition, 82.1% of the full scale IQ (FSIQ) estimates fell within the 95% confidence interval of the original score. We conclude that the SF is a reliable and valid measure to estimate FSIQ. It can be used in clinical and research settings when global estimates of intelligence are sufficient.

Introduction

A central aspect in the diagnostic process is the assessment of intellectual functioning. Although several measures have been developed over the years, the Wechsler Adult Intelligence Scale – third edition (WAIS-III; Wechsler, 1997b; Dutch version: Uterwijk, 2000b) remains one of the most commonly used tests to assess intelligence in adults (Rabin, Barr, & Burton, 2005) – also in intellectual disability (ID) services (MacLean, McKenzie, Kidd, Murray, & Schwannauer, 2011). It is generally preferred over other intelligence tests because it measures a broad range of cognitive abilities and gives a detailed profile of an individual's strengths and weaknesses.

The WAIS-III is composed of 14 subtests, 11 of which produce the summary scores verbal IQ (VIQ), performance IQ (PIQ) and full scale IQ (FSIQ). According to the manual, administration time of these 11 subtests averages 75 minutes, with a range of 60–90 minutes (Wechsler, 1997a; Dutch version: Uterwijk, 2000a). However, according to Ryan, Lopez and Werth (1998), the administration time increases by 22%–28% in clinical samples. Moreover, despite the discontinue rule in many subtests and the subsequent administration of fewer items, the overall administration time does not seem to be reduced (Axelrod, 2001). This means that using the WAIS-III to assess intelligence is a time consuming process, also in individuals with ID. An experience-based estimate of the administration time of the WAIS-III in individuals with ID ranges between 90 and 150 minutes, partly due to factors such as a higher need for instructions, slower information processing speed and a longer time needed to shift between different tasks.

To overcome time constrains and possible problems with client fatigue, agitation and frustration, extensive research has been done in creating valid and reliable WAIS-III short forms (SFs). Both researchers and practitioners have criticised the use of these SFs for their questionable psychometric qualities – such as normative problems and statistical issues with calculating IQ that hamper the reliability and validity (Kaufman & Kaufman, 2001) – and loss of information regarding the specific profile of strengths and weaknesses. However, when estimating intellectual functioning without regard to the individual ability profile, SFs might provide a useful, valid and cost-effective alternative (Cavinez, Konold, Collins, & Wilson, 2009). The use of SFs is therefore accepted in certain situations, such as when global estimates of intelligence are sufficient or for comparison of groups in a research setting (Kaufman & Kaufman, 2001). There are broadly two ways to create a SF, either by reducing the number of items in each subtest (selected item SFs) or by reducing the number of subtests (selected subtest SFs). Selected subtest SFs are generally preferred over selected item SFs, due to the questionable reliability (Silverstein, 1990) and validity (Kaufman & Kaufman, 2001) of the latter. In the selected subtest method, subtests are administered in their entirety, but the number of subtests is reduced. Numerous of these SFs exist, ranging from two to seven or even nine subtests in differing combinations (Groth-Marnat, 2009; Kaufman & Lichtenberger, 2006) but always taking into account both

accuracy in estimating intelligence and time savings (Schrimsher, O'Bryant, O'Jile, & Sutker, 2008).

The need for a more rapid estimation of intelligence is also reflected in the development of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) and more recently the second version (WASI-II; Wechsler, 2011). The WASI is a standardised and reliable measure of intellectual functioning. It consists of four subtests (Vocabulary, Similarities, Block design and Matrix reasoning) that are similar to their WAIS-III and WAIS-IV (Wechsler, 2008, 2012) counterparts but include a number of separate items. The selection of the subtests was based on research indicating that these subtests correlated most strongly with general intellectual functioning, thus FSIQ (Kaufman, 1990; Sattler, 2001). According to the manual, the four subtests can be administered in around 30 minutes (range 25–41 minutes) and result in VIQ, PIQ and FSIQ scores. Despite its high correlation with the WAIS-III (FSIQ: Pearson's $r = 0.92$), the WASI is a separate test. Ringe, Saine, Lacritz, Hynan and Cullum (2002) therefore conclude that a direct comparison to the WAIS-III is hampered by differences in items. Moreover, research has shown that a WASI-based WAIS-III SF (i.e. a tetrad WAIS-III SF comprising of Vocabulary, Similarities, Block design and Matrix reasoning) also provided an accurate estimate of FSIQ scores (Schrimsher et al., 2008) and even outperformed the WASI in a clinical sample (Axelrod, 2002). Since a Dutch version of these abbreviated intelligence scales has not been developed, neither test can be used in a Dutch population.

It has been recognised that SFs must be validated separately on individual populations, because of potential differences in appropriateness across populations (Schopp, Herman, Johnstone, Callahan, & Roudebush, 2001). Individuals with ID can be considered a separate population because of their specific cognitive profile that could potentially affect performance on the SF tasks. Moreover, the restricted IQ range of this population might hamper validity and reliability of existing SFs. To the best of our knowledge, few studies have been published on the use of SFs to assess intellectual functioning in individuals with ID (Alley, Allen, & Leverett, 2007; Finch, Ollendick, & Ginn, 1973; Nagle & Belle, 1995; Watkins, Himmell, Polk, & Reinberg, 1988) of which only one used the WAIS-III. Alley et al. (2007) compared the validity of two WAIS-III selected item SFs in a sample of 59 individuals with ID (FSIQ ≤ 79) and concluded that both SFs performed reasonably well in estimating intelligence. However, as noted before, the reliability and validity of selected item SFs are questionable. A validated WAIS-III SF might be useful in the diagnostic process in ID services and may also be of use to researchers seeking a global estimation of intelligence or to compare groups. Even though a new version of the WAIS-III, the WAIS-IV (Wechsler, 2008), has recently been published, practitioners and researchers continue to use the WAIS-III (Reid-Arndt, Allen, & Schopp, 2011; Van der Heijden, Van den Bos, Mol, & Kessels, 2013; Loring & Bauer, 2010). Indeed, the Dutch version of the WAIS-IV has only been published very recently (Wechsler, 2012), and the WAIS-III is still widely used in practice. The WAIS-III therefore remains useful for future research involving archival data and for

practitioners interested in comparing their clients' current cognitive ability with past evaluations of cognitive ability that were done with the WAIS-III. In fact, Loring and Bauer (2010) have suggested that using the WAIS-III is appropriate until there is sufficient evidence of the usefulness of the WAIS-IV for diagnosis and clinical decision making.

Considering the lack of a reliable and valid SF that can be used for individuals with ID, we conducted a study to investigate the reliability and validity of a selected subtest SF of the WAIS-III in a sample of individuals with mild to borderline intellectual disability (MBID, IQ 50–85, American Psychiatric Association, 2002; Schalock et al., 2010). The subtests included in our SF were derived from the WASI. They correlate strongly with general intellectual functioning (Kaufman, 1990; Sattler, 2001), are highly reliable (Wechsler, 1997a; Wechsler, 1999) and have been shown to provide accurate estimates of FSIQ scores in other populations (Axelrod, 2002; Schrimsher et al., 2008). It was hypothesised that our SF would also produce accurate FSIQ estimates in this population of individuals with MBID.

Method

Participants

Participants (N = 117; 99 men) had a mean age of 37.69 (SD = 10.97) years. They were all administered to forensic psychiatric centre Oldenkotte (n = 28) or treatment facility Trajectum Noord (n = 89). Trajectum is a facility specialised in the treatment and care for individuals with MBID with behavioural and/or psychiatric problems. All participants had been diagnosed with mild (IQ: 50–69; 37.6%, n = 44) or borderline (IQ: 70–85; 62.4%, n = 73) ID. The mean FSIQ was 71.34 (SD = 8.00; range = 52–85). The participants had an average age of 33.38 years (SD = 10.81) at the time of testing. Besides MBID, participants were diagnosed with other co-morbid disorders. Substance use disorders (37.1%, n = 62), psychotic disorders (15.0%, n = 25) and personality disorders (Cluster B: 45.3%, n = 29; personality disorders not otherwise specified: 45.3%, n = 29) were diagnosed most often. As the participants were admitted to a closed treatment facility, they were currently unable to engage in substance use. The psychiatric condition of the participants was stable at the time of testing. All participants had the Dutch nationality and the majority (81.2%, n = 95) originated from the Netherlands.

Procedure

A full Dutch version of the WAIS-III (Uterwijk, 2000b; Wechsler, 1997b) was administered by a trained diagnostic as a standard procedure in the diagnostic process at the start of the admission to the clinic. This study was based on archival data, collected between 2007 and 2012. The WAIS-III was administered and scored according to the procedure outlined in the manual (Wechsler, 1997b). Raw scores were converted to age-corrected scaled scores equivalents, which were then converted to IQ scores. For our WAIS-III SF, scaled

scores of four subtests (i.e. Vocabulary, Similarities, Block design and Matrix reasoning) were used. We used the statistical approach described in Crawford, Allum and Kinion (2008) to estimate FSIQ scores of all participants. In this approach, the scaled scores of the subtests were combined into a composite and transformed to an IQ metric ($M = 100$, $SD = 15$). The composite thus forms a free standing measure that can be used to estimate intellectual functioning.

Results

Psychometric qualities

The psychometric qualities of our tetrad WAIS-III SF are summarised in Table 1. As we only used the SF to estimate FSIQ, only the psychometric qualities of that composite are reported in the text. To explore the psychometric qualities, we first obtained the reliability of the FSIQ composite using the formula presented in Tellegen and Briggs (1967). The reliability of the SF in this sample was excellent ($r = 0.96$) and only marginally lower than the reliability of the full WAIS-III according to the manual ($r = 0.98$). We then calculated the standard error of measurement of the SF FSIQ estimate (Crawford et al., 2008), which is an estimate of the amount of error in the measure and directly relates to the reliability of that measure. The standard error of measurement was 3.00 for the SF FSIQ estimate, as opposed to 2.35 for the full WAIS-III FSIQ.

The second step of exploring the psychometric qualities was to investigate the validity of the SF. Generally, this has been done by calculating correlations between the FSIQ scores according to the full WAIS-III and the FSIQ estimates based on the SF and running *t*-test comparisons (Watkins et al., 1988). Using Pearson product-moment correlation coefficient, there was a strong, positive correlation between the two measures, $r = 0.92$, $p < .001$. When correcting for redundancy – that is, taking into account the redundancy of correlating two tests that include the same items (Levy, 1967) – the correlation remained strong, $r = 0.89$, $p < .001$. However, there were significant differences between FSIQ scores based on the full WAIS-III ($M = 71.34$, $SD = 8.00$) and the SF ($M = 73.26$, $SD = 7.51$), $t(116) = -6.52$, $p < .001$. The eta squared statistics (0.27) indicated a large effect size. Nonetheless, the average discrepancy score between the full WAIS-III FSIQ and the estimated FSIQ was only -2.01 points ($SD = 3.23$), indicating small differences between the two measures.

Estimation of intellectual functioning

Several measures were used to test the accuracy in estimating FSIQ scores using the tetrad WAIS-III SF: the rate of correctly identified ID (i.e. an FSIQ estimate < 85), the percentage of FSIQ estimates that fell in the same IQ category (mild ID vs. borderline ID), the cumulative percentage of discrepancies between full WAIS-III FSIQ scores and FSIQ

Table 1 Summary Statistics and Psychometric Qualities of the WAIS-III Short Form.

	M	SD	SEM	Reliability[b]	Pearson *r*[c]	Corrected *r*[d]
Full WAIS-III						
Full scale IQ	71.34	8.00	2.35	0.98		
Verbal IQ	70.97	9.50	2.50	0.97		
Performance IQ	72.44	10.39	3.97	0.93		
Short Form[a]						
Est. full scale IQ	73.29	7.50	3.00	0.96	0.92	0.89
Est. verbal IQ	72.44	9.77	3.67	0.94	0.88	0.82
Est. performance IQ	74.46	9.18	3.97	0.93	0.82	0.73

Note. WAIS-III = Wechsler Adult Intelligence Scale – Third Edition (Wechsler, 1997b). SEM = standard error of measurement.

[a] WAIS-III short form based on four subtests (Vocabulary, Similarities, Block design and Matrix reasoning).

[b] Calculated using the formula presented in Tellegen and Briggs (1967).

[c] Pearson *r* correlation with WAIS-III score.

[d] Calculated using the formula presented in Levy (1967).

estimates based on the SF and the percentage of FSIQ estimates that fell within the 90% and 95% confidence interval (CI) of the original score (Alley et al., 2007; Wymer, Rayls, & Wagner, 2003).

First, the correct identification of ID and the predictive power of the SF were examined. The WAIS-III SF correctly identified ID (IQ < 85) in the majority of cases (97.4%, *n* = 114). Only three participants were classified as having below average IQ, but the FSIQs of these participants were only marginally higher than 85 (FSIQs 86 and 88). In addition, the SF correctly identified the IQ category in 86.3% (*n* = 101). The positive and negative predictive power as well as the sensitivity, specificity and the likelihood ratio of the SF were calculated for individuals with borderline ID and mild ID separately and are reported in Table 2. All predictive values were high (> 0.80) for both individuals with borderline ID and mild ID. In addition, it was almost seven times more likely that a participants was correctly identified as having borderline ID compared to a participant whose IQ category was incorrectly diagnosed by the SF. This likelihood ratio was even higher for individuals with mild ID, for whom it was 16 times more likely to be correctly identified.

Next, we calculated the cumulative percentage of discrepancies between full WAIS-III FSIQ scores and FSIQ estimates. As can be seen in Table 3, 84.6% (*n* = 99) of the FSIQ estimates fell within five points of the original score and all estimates fell within 10 points of the original score. The SF slightly overestimated FSIQ by two points in comparison to the full WAIS-III. In addition, 82.1% (*n* = 96) of the FSIQ estimates fell within the 95% CI of the original score and 72.6% (*n* = 85) fell within the 90% CI of the original score. For VIQ and PIQ estimates, these percentages were lower. Seventy-two percent (*n* = 84) of the VIQ

Table 2 Positive predictive power, negative predictive power, sensitivity, specificity and likelihood ratio of the WAIS-III short form separated for individuals with borderline intellectual disability and individuals with mild intellectual disability.

	Borderline ID	Mild ID
Positive predictive power	0.92	0.91
Negative predictive power	0.84	0.92
Sensitivity	0.90	0.92
Specificity	0.86	0.94
Likelihood ratio	6.65	16.09

Note. WAIS-III = Wechsler Adult Intelligence Scale – Third Edition (Wechsler, 1997b); ID = Intellectual Disability.

Table 3 Frequency, percentage, and cumulative percentage of discrepancies between full WAIS-III FSIQ scores and estimates based on the WAIS-III short form.

Discrepancy	Frequency	Percentage	Cumulative percentage
-9	1	0.9	0.9
-8	2	1.7	2.6
-7	5	4.3	6.8
-6	10	8.5	15.4
-5	6	5.1	20.5
-4	17	14.5	35.0
-3	18	15.4	50.4
-2	10	8.5	59.0
-1	14	12.0	70.9
0	7	6.0	76.9
1	8	6.8	83.8
2	4	3.4	87.2
3	7	6.0	93.2
4	6	5.1	98.3
5	2	1.7	100.0

Note. WAIS-III = Wechsler Adult Intelligence Scale – Third Edition (Wechsler, 1997b); FSIQ = full scale IQ.

estimates fell within five points of the original score and 97.4% (n = 114) within 10 points of the original score. Seventy-eight percent (n = 91) of the estimates fell within the 95% CI of the original score and 68.4% (n = 80) fell within the 90% CI. With regard to PIQ estimates, 65.0% (n = 76) fell within five points of the original score and 89.7% (n = 105) within 10

points of the original score. Ninety-eight cases (83.8%) fell within the 95% CI of the original score and eighty-seven cases (74.4%) fell within the 90% CI of the original score. This indicates that the SF gives an accurate estimate for FSIQ and less so for VIQ and PIQ scores.

Discussion

The results of our study indicate that a WASI-based tetrad SF of the WAIS-III (Uterwijk, 2000b; Wechsler, 1997b) is a reliable and valid measure to estimate FSIQ in individuals with MBID. The SF correctly identified ID in general and the correct IQ category more specifically in the majority of cases. In addition, 82% of the FSIQ estimates fell within the 95% CI of the original score and 73% of the estimates fell within the 90% CI of the original score. The reliability of the SF was high and there was a strong, positive correlation between the SF and the full WAIS-III. The SF meets two of the three minimal psychometric criteria for SFs set by Donders and Axelrod (2002), that is a reliability greater than or equal to 0.90 and part-whole correlations greater than or equal to 0.82. Despite the SF not meeting the third criterion of at least 81% of the SF estimates falling within the 90% CI of the full WAIS-III, the average discrepancy score between the full WAIS-III and the estimated FSIQ was small. This indicates that the difference between the two measures was small. Although the SF is made up of both verbal and performance subtests and should therefore be able to predict VIQ and PIQ in addition to FSIQ, an important finding of this study is that the SF is more accurate in predicting FSIQ and VIQ compared to PIQ scores. This is also demonstrated in the lower reliability and validity of the PIQ estimates compared to the FSIQ and VIQ estimates. These results replicate findings with other WAIS-III SFs (Axelrod, Ryan, & Ward, 2001; Ryan & Ward, 1999).

Of interest with regard to this sample is the frequent diagnosis of psychiatric disorders in combination with the ID. Importantly, experts predict that 30–35% of the individuals with intellectual and developmental disabilities also have a psychiatric illness (Fletcher, 2014) and the prevalence of psychiatric disorders among this group might be 4–5 times higher than in the general population (Rush, Bowman, Eidman, Toole, & Mortenson, 2004). For example, sixty-two participants were diagnosed as having substance use disorder. As in other research (Chaplin, Gilvarry, & Tsakanikos, 2011; VanDerNagel, Kiewik, Buitelaar, & De Jong, 2011a), problematic use of alcohol, cannabis and cocaine were the most frequent diagnoses. Polysubstance use disorders and having several abuse or dependency diagnoses at once were common, indicating that a large percentage of participants abused and/or were dependent on several different substances. This is important because research in individuals without ID showed that co-morbid disorders such as chronic alcohol and drug use, but also psychotic disorders, autism spectrum disorders and attention deficit/hyperactivity disorder negatively affect executive functioning (Doyle, 2006; Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Goldstein et al., 2004; Reichenberg,

2010). It is therefore important to consider the sample's characteristics in relation to both their performance on neuropsychological tests in general and generalisation of the current results more specific.

This study has several limitations. First, the estimated IQ scores are derived from administration of a full WAIS-III. Although this is allowed for a comparison of the SF with the full WAIS-III within the same sample, it leaves unclear how the SF would perform in estimating IQ when administered in itself. In addition, it is possible that client fatigue, psychiatric condition, motivation or within-test learning affects performance on the entire test – factors that are subsequently reflected in these data (Axelrod, 2002; Kulas & Axelrod, 2002). It is therefore advised to replicate this study with a between-subject design. Second, the psychometric qualities we investigated are limited in nature. A suggestion for future research is therefore to also examine other forms of reliability and validity, such as test-retest reliability of the SF. Finally, the SF we used did not maintain the four-factor structure of the WAIS-III (i.e. verbal comprehension, perceptual reasoning, working memory and processing speed). It has been suggested that maintaining the factor structure provides more detailed diagnostic information and increases the construct validity (Crawford et al., 2008; Girard, Axelrod, & Wilkins, 2010). However, research has shown that the four-factor structure might not apply in individuals with ID and a two-factor structure with VIQ and PIQ provides a better fit (Jones, Van Schaik, & Witts, 2006; MacLean et al., 2011), although the disharmonic intelligence profiles often seen by clinicians might call for the use of four structures to gain more insight in the individual's ability profile.

Keeping in mind the critique on the use of SFs, we would like to conclude with some suggestions. First, the WASI-based tetrad WAIS-III SF can be used to predict FSIQ in individuals with MBID. Because the SF is more accurate in estimating FSIQ compared to VIQ and PIQ, researchers and practitioners are advised to be cautious when estimating VIQ and PIQ. Second, caution is advised when using the SF in other populations due to potential differences in utility and psychometric qualities of the SF. Third, the SF should not be used to diagnose clients or to make clinical inferences about a client's ability profile. It can, however, be used in both clinical and research settings when global estimates of intelligence are sufficient.

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Cognitive deficits in problematic drinkers with mild to borderline intellectual disability

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Van Duijvenbode, N., Didden, R., VanDerNagel, J. E. L., Korzilius, H. P. L. M., & Engels, R. C. M. E. (submitted). *Cognitive deficits in problematic drinkers with and without mild to borderline intellectual disability.*

Abstract

We examined cognitive deficits in problematic drinkers with and without mild to borderline intellectual disability (MBID). Problematic drinkers were expected to show a significantly lower estimated performance IQ, but not a lower estimated verbal IQ, compared to light drinkers. Participants ($N = 474$) were divided into four groups based on IQ and severity of alcohol use-related problems. IQ was estimated using (a short form of) the Wechsler Adult Intelligence Scale third edition. Severity of alcohol use-related problems was assessed using the Alcohol Use Disorder Identification Test. There were no significant differences between light and problematic drinkers on estimated verbal IQ. Within the group without MBID, estimated performance IQ was significantly lower. Estimated performance IQ was not lower in problematic drinkers with MBID compared to light drinkers with MBID. The results are indicative of cognitive deficits in problematic drinkers without MBID. Screening for cognitive deficits with additional instruments is advised.

Introduction

Alcohol use is highly prevalent among the adult population. For example, national data from the United States indicate that more than 80% of the adult population has ever drank alcohol in his or her life (Substance Abuse and Mental Health Services Administration, 2014) and that approximately 12% of this population is known with an alcohol use disorder (Merikangas & McClair, 2012). Similar findings have been reported in studies among European countries (Rehm, Room, Van den Brink, & Jacobi, 2005). It is becoming increasingly clear that problematic alcohol use and alcohol use disorder also pose a major problem among individuals with mild to borderline intellectual disability (Carroll Chapman & Wu, 2012; Kerr, Lawrence, Darbyshire, Middleton, & Fitzsimmons, 2013; Van Duijvenbode et al., 2015). In fact, although the prevalence of alcohol use among individuals with mild to borderline intellectual disability (MBID[1]; IQ 50–85, American Psychiatric Association, 2013) is reported to be similar or lower compared to that in the general population (see To, Neirynck, Vanderplasschen, Vanheule, & Vandevelde, 2014; VanDerNagel, Kiewik, Buitelaar, & De Jong, 2011a), their risk of developing problematic alcohol use is higher (Burgard, Donohue, Azrin, & Teichner, 2000; McGillicuddy, 2006).

Problematic alcohol use is associated with a wide range of physical, psychological and social adverse consequences (Patussi, Mezzani, & Scafato, 2004; Walter, Dammann, & Klapp, 2004), that are thought to be more prevalent and more severe in individuals with MBID (Slayter, 2008). For example, the simultaneous use of prescribed psychotropic medication can alter the effects of these medications and may lead to severe health problems (Taggart, McLaughlin, Quinn, & Milligan, 2006). Problematic alcohol use can also cause social and interpersonal problems, including problems with the social network, housing, work and recreation (e.g., Slayter, 2008; To et al., 2014) and is a risk factor for emotional and behavioural problems (Didden, Embregts, Van der Toorn, & Laarhoven, 2009) and delinquency (McGillivray & Moore, 2001).

Less is known about the cognitive consequences of problematic alcohol use in problematic drinkers with MBID. Research in individuals without MBID indicates that problematic alcohol use negatively affects several cognitive functions (Crews et al., 2005; Loeber et al., 2009a), especially those that are related to the frontal lobe area of the brain (Coleman, Liu, Oguz, Styner, & Crews, 2014; Moselhy, Georgiou, & Kahn, 2001). For example, working memory capacity, inhibitory control, processing speed, problem solving abilities, cognitive and behavioural flexibility and emotion regulation all seem to be impaired in problematic drinkers (e.g., Bravers et al., 2014; Ratti, Bo, Giardini, & Soragna, 2002; Trick, Kempton, William, & Duka, 2014). In addition, while cognitive functioning is thought to improve again after a period of abstinence, some deficits remain even after weeks or years of abstinence or permanently (Fein, Klein, & Finn, 2004; Petry, 2001). Despite the lack of research on this topic, it seems reasonable to assume that similar cognitive deficits can also be found in problematic drinkers with MBID.

Cognitive deficits in problematic drinkers have generally been assessed with questionnaires or (computerised) tasks for executive control. However, standardised intelligence tests could also be used for this purpose (Gläscher et al., 2010). These cover a broad range of cognitive functions, allow for a closer examination of the cognitive strengths and weaknesses of problematic drinkers and overcome some of the critique on executive control tasks (e.g., problems with the accuracy, sensitivity and validity of the measures; Chan, Shum, Toulopoulou, & Chen, 2008). However, studies using this approach have been lacking in problematic drinkers with and without MBID.

The primary goal of the present study was to examine cognitive deficits in problematic drinkers with and without MBID. Cognitive functioning was assessed using the Dutch version of the Wechsler Adult Intelligence Scale third edition (WAIS-III-NL; Uterwijk, 2000b), which is one of the most commonly used tests to assess intelligence in adults (Rabin, Barr, & Burton, 2005) and is still widely used in clinical practice in intellectual disability services (MacLean, McKenzie, Kidd, Murray, & Schwannauer, 2011) – despite the fact that the new version of the WAIS, the WAIS-IV (Wechsler, 2008; Dutch translation: Wechsler, 2012), has been published (Reid-Arndt, Allen, & Schopp, 2011; Van der Heijden, Van den Bos, Mol & Kessels, 2013). Both (estimated) verbal IQ and (estimated) performance IQ were measured. Due to our cross-sectional design, we will not be able to study causal relationships (i.e., cognitive deficits as a result of problematic alcohol use), but rather cognitive deficits associated with problematic alcohol use by comparing light and problematic drinkers. In other words, we aimed to study the relationship between estimated verbal and performance IQ and severity of alcohol use-related problems *within* individuals with and without MBID. In addition, we aimed to study the potential differences in cognitive profiles of light and problematic drinkers *between* individuals with and without MBID. In line with previous studies suggesting that verbal reasoning and vocabulary are relatively intact in problematic drinkers (e.g., Bijl, De Bruin, Kenemans, Verbaten, & Böcker, 2005), it was hypothesised that there would be no significant differences in estimated verbal IQ between light and problematic drinkers with and without MBID. Estimated performance IQ, on the other hand, was hypothesised to be significantly lower among problematic drinkers with and without MBID, because it taps into several cognitive functions implicated as a result of problematic alcohol use (e.g., problem solving, reasoning, processing speed; Uterwijk, 2010b). Considering the correlation between intelligence and education (Deary & Johnson, 2010), we controlled for educational background in the statistical analyses.

Method

Participants

For this study, the participant samples of our previous studies into the neuropsychology of problematic alcohol use in individuals with MBID were pooled. Participants with missing scores on the key variables (i.e., IQ and severity of alcohol use-related problems) were excluded (n = 32). In total, 474 participants (317 men, 66.9%) were included. They had a mean age of 37.9 years (SD = 1.67, range = 18–68 years). The majority of participants originated from the Netherlands (n = 434, 91.6%), while the others originated from Turkey/Morocco (n = 10, 2.1%), Surinam/Dutch Antilles (n = 8, 1.8%), or other Western (n = 10, 2.1%) or non-Western (n = 12, 2.6%) countries. All participants spoke Dutch fluently. Their educational background ranged from primary school (n = 67, 14.1%) to university college (n = 87, 18.4%). Most of the participants finished some form of higher education (n = 290, 61.2%), although a small number of participants had no finished education at all (n = 11, 2.3%).

More than half of the participants (n = 308, 65.0%) received outpatient or residential care from organisations within intellectual disability care (n = 153, 32.3%) or addiction medicine (n = 155, 32.7%). In total, 235 participants (49.6%) were diagnosed with one or more psychiatric disorders. Substance use disorder (n = 173, 36.5%), autism spectrum disorder (n = 40, 8.4%) and attention deficit hyperactivity disorder (n = 33, 7.0%) were diagnosed most often. Forty-six participants (9.7%) were diagnosed with a personality disorder. In addition, 178 (37.6%) participants were prescribed psychotropic medication, including antidepressants, antipsychotics and benzodiazepines.

Material

Substance use

General patterns of substance use were assessed with the Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q, VanDerNagel, Kiewik, Van Dijk, De Jong, & Didden, 2011b). The SumID-Q is a Dutch-language semi-structured interview to assess substance use in adults with MBID. It is adapted to the needs of those with MBID by avoiding lengthy phrasing and difficult wording and using pictures in addition to asking verbal questions (VanDerNagel, Kemna, & Didden, 2013). Using this interview method, participants reported their average, general frequency and quantity of alcohol use, which was then converted into standard units of 10g of alcohol to generate a measure of the weekly alcohol consumptions of participants (International Center for Alcohol Policies, 2010).

The severity of alcohol use-related problems was measured with the Alcohol Use Disorder Identification Test (AUDIT; Babor, Higgings-Biddle, Saunders, & Monteiro, 2001; Dutch translation: Schippers & Broekman, 2010), which is integrated in the SumID-Q. The AUDIT is a self-report measure of 10 questions about the amount, frequency and

consequences of alcohol use. All answers are scored on a 5-point Likert-scale ranging from 0 (*never*) to 4 (*almost every day*). The maximum score is 40, with higher scores reflecting more severe alcohol use-related problems. According to the manual, a score of 8 or higher is indicative of hazardous alcohol use, while a score of 16 or higher suggests the presence of alcohol use disorder (Babor et al., 2001). The total AUDIT score was used to classify participants as either light drinkers (AUDIT score < 8) or problematic drinkers (AUDIT score ≥ 8). The internal consistency of the AUDIT in the current study was good (Cronbach's alpha = .90, mean inter-item correlation = .47).

IQ

IQ was assessed using the most recent scores on the Dutch version of the Wechsler Adults Intelligence Scale third edition (WAIS-III-NL; Uterwijk, 2000b) in the participants' files. In the Netherlands, intelligence tests are usually not re-administered every two years, but instead only if clinicians notice a change in (cognitive) functioning or to answer specific diagnostic questions. It is therefore assumed that the most recent IQ scores in the participants' files reflect their current cognitive functioning. If IQ scores were not available, a short form of the WAIS-III was administered (n = 311, 65.6%). The use of short forms is generally accepted when comparing groups in a research setting (Kaufman & Kaufman, 2001) and overcomes time constrains and possible problems with participant fatigue, agitation and frustration (Van Duijvenbode, Didden, Van den Hazel, & Engels, 2016a). The short form consists of four subtests of the WAIS-III-NL, namely two subtests for verbal IQ (Vocabulary and Similarities) and two subtests for performance IQ (Block design and Matrix reasoning), based on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). It can be administered in approximately 30 minutes. Van Duijvenbode et al. (2016a) conclude that the short form can be used to estimate full scale, verbal and performance IQ in individuals with MBID. Estimated full scale IQ was used to classify participants as having MBID (IQ < 85) or without MBID (IQ ≥ 85).

Procedure

We used a convenience sample in the current study. Participants were recruited from organisations for addiction medicine and intellectual disability care. The selection was made by the treatment team based on the inclusion criteria. Participants were also recruited via advertisements on social media, flyers at the Radboud University and word of mouth. Inclusion criteria were a minimum age of 18 years, access to alcohol use and/or alcohol use in the last 1.5 months and stable functioning (i.e., free from psychotic, manic, depressive and withdrawal symptoms). Participants with a history of problematic alcohol use who were currently abstaining longer than 1.5 months were excluded from participating.

All participants were provided with written and verbal information about the background and aims of the study. It was stressed that all information would be treated

confidentially and anonymously and that declining or withdrawing from participating had no negative consequences. Both participants and treatment teams (if applicable) provided written informed consent. The study consisted of one session of approximately 1 to 1.5 hours, in which participants first provided general demographic information. If necessary, IQ was measured using the WAIS-III-NL short form. Then, substance use and the severity of alcohol use-related problems was assessed using the SumID-Q and AUDIT. As this study is part of a larger research project on the neuropsychology of problematic alcohol use in individuals with MBID, all participants also completed computerised tasks to measure cognitive biases (i.e., visual dot probe task, approach avoidance task and word association task; Van Duijvenbode, Didden, Korzilius, & Engels, 2016b; Van Duijvenbode et al., in press) and executive control (i.e., Corsi block tapping task, Go/No-go task; Van Duijvenbode, Didden, Korzilius, & Engels, submitted). Participants were allowed to take a break in between tasks whenever necessary. Finally, participants were thanked for their time and received a gift worth €5 (US $6.50, GBP £3.70) for their participation.

The research project was approved by the Ethics Committee of the Faculty of Social Sciences, Radboud University, Nijmegen, the Netherlands (ECG2012-1301-003).

Statistical analyses

All data were analysed using IBM SPSS Statistics (Version 21). A one-way analysis of variance (ANOVA) and chi-square analyses were conducted to compare demographic variables between groups (i.e., light and problematic drinkers with and without MBID). To test the relationship between severity of alcohol use-related problems and cognitive functioning, we first calculated Pearson product-moment correlation coefficients. To further explore the relationship between severity of alcohol use-related problems and cognitive functioning (i.e., to study potential differences in cognitive profiles of light and problematic drinkers *between* individuals with and without MBID), a one-way ANOVA was conducted. These analyses were supplemented with analyses of covariance (ANCOVA), with educational background as a covariate. The estimated verbal and performance IQ of all four groups was depicted in a scatter plot. A power analysis (with G*Power Version 3.1.92) showed that with the number of participants in the sample and the statistical tests used a power of 1.00 was achieved at a medium effect size ($f = .25$) and α of .05.

Results

Group characteristics

Estimated full scale IQ and severity of alcohol use-related problems (AUDIT score) were used to divide participants in four groups: light drinkers without MBID ($n = 116$, 24.5%), problematic drinkers without MBID ($n = 116$, 24.5%), light drinkers with MBID ($n = 109$, 23.0%) and problematic drinkers with MBID ($n = 133$, 28.1%). As expected, a one-way

ANOVA with post-hoc Tukey HSD test showed that problematic drinkers in both IQ groups consumed significantly more alcohol per week and experienced more severe alcohol use-related problems than light drinkers. Similarly, estimated full scale IQ differed significantly between participants with and without MBID. Within these two IQ groups, problematic drinkers scored significantly lower on estimated full scale IQ than light drinkers (see Table 1). A chi-square analysis showed that groups also differed on gender ratio ($\chi^2(3, N = 474) = 38.04, p < .001$), with relatively few female problematic drinkers, and educational background ($\chi^2(15, N = 474) = 236.86, p < .001$)[2]. Participants without MBID had a higher educational background than participants with MBID. Groups did not differ on cultural background and age (*p*s > .05).

Correlational analyses

To explore the relationship between severity of alcohol use-related problems and cognitive functioning, we first calculated Pearson product-moment correlation coefficients. Results showed that the severity of alcohol use-related problems (AUDIT score) correlated weakly with estimated performance IQ ($r = -.14, p = .003$), but not with estimated verbal IQ ($r = -.01, p = .933$). When calculating the Pearson product-moment correlation coefficients for participants with and without MBID separately, we found that for participants without MBID AUDIT score correlated weakly with estimated verbal IQ ($r = -.15, p = .020$) and strongly with estimated performance IQ ($r = -.43, p < .001$). For participants with MBID, on the other hand, AUDIT score correlated positively with estimated verbal IQ ($r = .23, p < .001$), but not with estimated performance IQ ($r = .12, p = .060$). A Fisher *r*-to-*z*-transformation indicated that both the correlation between AUDIT score and estimated verbal IQ (*z* difference = -4.17, $p < .001$) as well as the correlation between AUDIT score and estimated performance IQ (*z* difference = -6.28, $p < .001$) were significantly stronger in participants without MBID than in participants with MBID, indicating that the relationship between severity of alcohol use-related problems (AUDIT score) and IQ scores differed between participants with and without MBID.

Group differences

To further explore the relationship between severity of alcohol use-related problems and cognitive functioning (i.e., to study potential differences in cognitive profiles of light and problematic drinkers *between* individuals with and without MBID), a one-way ANOVA with post-hoc Tukey HSD test was conducted. The estimated verbal and performance IQs of all four groups are depicted in Figure 1. It illustrates that the differences between light and problematic drinkers seem to be small in both participants with and without MBID.

With regard to estimated verbal IQ, the results showed a large significant difference between the four groups ($F(3,470) = 278.75, p < .001, \eta_p^2 = .64$). In addition to the expected differences in estimated verbal IQ between participants with and without MBID, post-hoc comparisons using the Tukey HSD test indicated that light ($M = 99.26$, $SD = 10.67$) and

Table 1 Participant Characteristics per Group (N = 474): Light Drinkers without Mild to Borderline Intellectual Disability (MBID; n = 116), Problematic Drinkers without MBID(n = 116), Light Drinkers with MBID (MBID; n = 109), and Problematic Drinkers with MBID (n = 133).

	Without MBID		**With MBID**		*F* (3,470)	*p*	η_p^2
	Light drinkers	Problematic drinkers	Light drinkers	Problematic drinkers			
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*			
Age	36.23 (13.86)	40.03 (13.20)	36.05 (13.60)	39.02 (13.73)	2.50	.059	.02
Est. full scale IQ	102.89 (9.86)	98.03 (10.16)	68.91 (9.20)	72.51 (8.62)	395.58	< .001	.72
AUDIT score	4.48 (2.08)	19.79 (7.57)	3.41 (2.22)	20.66 (7.35)	334.21	< .001	.68
Weekly alcohol consumption	4.01 (4.14)	91.74 (87.08)	2.91 (4.17)	106.36 (99.67)	79.09	< .001	.34

Note. AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001); η_p^2 = partial eta squared.

problematic drinkers (M = 98.18, SD = 10.93) without MBID did not differ significantly from each other on estimated verbal IQ. This result remained when controlling for educational background in an ANCOVA. Problematic drinkers with MBID (M = 72.98, SD = 10.34) had a significantly higher estimated verbal IQ than light drinkers with MBID (M = 69.00, SD = 9.67), although this result disappeared when controlling for educational background in an ANCOVA.

With regard to estimated performance IQ, there also was a large significant difference between the four groups ($F(3,470) = 258.29$, $p < .001$, $\eta_p^2 = .62$). As expected, a post-hoc Tukey HSD test indicated that, overall, participants without MBID had a higher estimated performance IQ than participants with MBID. More interestingly, however, is that we found problematic drinkers without MBID (M = 97.77, SD = 13.61) to have a significantly lower estimated performance IQ than light drinkers without MBID (M = 106.16, SD = 11.78), while light (M = 72.30, SD = 11.65) and problematic (M = 73.13, SD = 9.47) drinkers with MBID did not differ significantly from each other on estimated performance IQ. These results remained when deleting two participants with outliers on estimated performance IQ and when controlling for educational background in an ANCOVA.

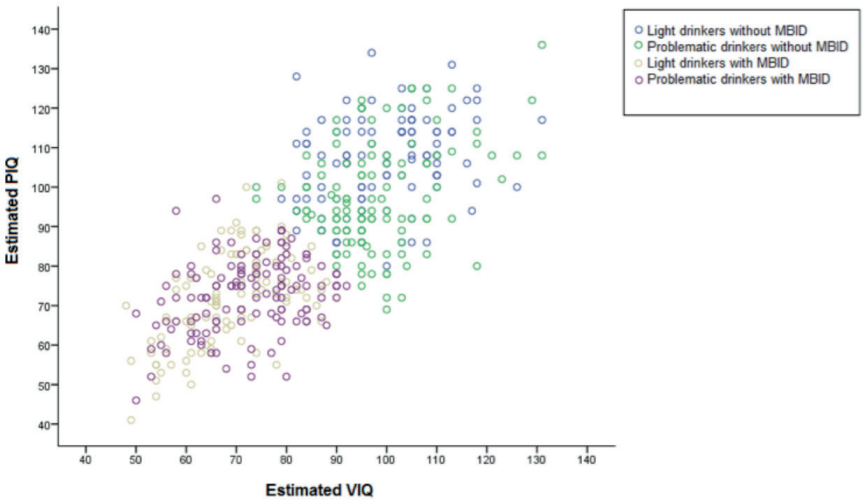

Figure 1 A scatterplot of the estimated verbal IQ (VIQ) and performance IQ (PIQ) for light and problematic drinkers with and without mild to borderline intellectual disability (MBID).

Discussion

The aim of the present study was to examine cognitive deficits in problematic drinkers with and without MBID using (a short form of) the Dutch version of the WAIS-III (Uterwijk, 2000b; Van Duijvenbode et al., 2016a). It was hypothesised that estimated performance IQ would be significantly lower among problematic drinkers compared to light drinkers, whereas estimated verbal IQ would not. This was expected to hold for both problematic drinkers with and without MBID.

The results partly support the hypotheses. In line with the expectations, we found that the severity of alcohol use-related problems correlated weakly with estimated performance IQ, but not with estimated verbal IQ. Indeed, there were no significant differences between light and problematic drinkers on estimated verbal IQ. This indicates there were no differences in verbal reasoning and vocabulary between light and problematic drinkers (see also Bijl et al., 2005). There was a significant difference between light and problematic drinkers without MBID on estimated performance IQ. Problematic drinkers without MBID had a significantly lower estimated performance IQ compared to light drinkers without MBID, even after controlling for educational background. This expands earlier research findings suggesting cognitive dysfunction in problematic drinkers, including impairments in processing speed, problem solving abilities and cognitive and behavioural flexibility (e.g., Bravers et al., 2014; Ratti et al., 2002; Trick et al., 2014).

Unexpectedly, however, the relationship between the severity of alcohol use-related problems and IQ scores seemed to differ between participants with and without MBID. Estimated performance IQ was not lower in problematic drinkers with MBID than in light drinkers with MBID. Thus, while problematic alcohol use is associated with cognitive deficits in individuals *without* MBID, we could not find these deficits – using this methodology – in individuals *with* MBID. The explanation for these results remains speculative. Perhaps there are no additive effects of MBID and problematic alcohol use on cognitive functioning, suggesting problematic alcohol use in individuals with MBID is not associated with a (further decline) in cognitive functioning (see also Van Duijvenbode et al., submitted). However, a more probable explanation is that our results are influenced by the characteristics of the WAIS-III-NL (Uterwijk, 2000b), for example concerns about the poor discriminability and differentiability in the lower IQ range (Whitaker, 2005) and potential problems with measurement invariance (MacLean et al., 2011). Similarly, the use of both the full WAIS-III and short forms might have contributed to these results.

We note several limitations of the current study. First, when IQ scores were not available in the participants' files, a WAIS-III short form was used (65.6% of the cases). Although the short form provides a valid and reliable estimate of full scale IQ, the estimates of verbal and performance IQ have shown to be less accurate (Van Duijvenbode et al., 2016a). In addition, the use of a short form limits the information regarding the

strengths and weaknesses of problematic drinkers. It is therefore advised to replicate our study using all subtests of an intelligence test, preferably the more recent version of the WAIS – the WAIS-IV (Wechsler, 2012). Second, the cross-sectional design of the current study prevents us to draw more firm conclusions about the nature of the cognitive deficits in problematic drinkers. For example, it is not clear if the cognitive deficits are a cause or effect of problematic alcohol use. It also remains unclear if these cognitive deficits are temporary or permanent. Future studies might therefore want to consider using a prospective design to address these issues. Third and last, the cognitive profiles of individuals with MBID can vary and there can be differences in individual profiles of cognitive strengths and weaknesses within the group making it difficult to draw firm conclusions about associations between cognitive profiles and problematic alcohol use in this target group. Similarly, problematic drinkers form a heterogeneous group when it comes to patterns of alcohol use (e.g., age of onset of alcohol use, duration of problematic alcohol use, consequences of alcohol use, number and types of other substances used) and type and degree of co-morbidity with physical and psychiatric problems. These factors can influence the effects of problematic alcohol use on the brain (Petrakis, Gonzalez, Rosenheck, & Krystal, 2002) and could be taken into account in future studies (e.g., by forming more homogeneous groups and using a prospective design).

Nonetheless, our results add to the knowledge base by studying cognitive deficits in problematic drinkers with and without MBID. Our results are indicative of cognitive deficits in problematic drinkers without MBID (see also Crews et al., 2005; Loeber et al., 2009a). More specifically, estimated performance IQ was significantly lower in problematic drinkers without MBID. Estimated performance IQ was not lower in problematic drinkers with MBID compared to light drinkers with MBID. Although these results could suggest that problematic alcohol use does not affect cognitive functioning (further) in problematic drinkers with MBID, the results could also be explained by potential problems with discriminability, differentiability and measurement invariance of the WAIS-III in the lower IQ range and the use of short forms to estimate verbal and performance IQ. The difference between verbal and performance IQ as a measure of cognitive decline as a result of problematic alcohol use does not seem useful in problematic drinkers with MBID. However, it is advised to replicate our study using another methodology, preferably using broad spectrum measures to take into account potential differences in profiles of cognitive strengths and weaknesses often seen in this group.

Our results imply that cognitive screening at the start of treatment might be beneficial. We provide two reasons why this would be important. First, identifying problematic drinkers with cognitive deficits and/or MBID in an early phase of the treatment may guide treatment choices (Allan, Kemp, & Golden, 2012; Cunha & Novaes, 2004). For example, attentional dysfunctioning, a lower working memory capacity, impaired organisational and planning skills and impaired self-monitoring – factors that have been associated with cognitive dysfunctioning, including with MBID – hamper the

usefulness of treatment programmes based on cognitive and behavioural change often used in addiction medicine (Allan et al., 2012). Identifying such factors in an early phase of the treatment thus allows problematic drinkers with these cognitive deficits and/or MBID to be entered into treatment interventions more tailored to their needs (McLaughlin et al., 2007). This, in turn, could possibly improve treatment outcome (Copersino et al., 2009; McLaughlin et al., 2007). Second, treatment itself could also be focused on improving the cognitive or executive functioning of problematic drinkers (Yücel & Lubman, 2007). One example of such a training is working memory training (Houben, Wiers, & Jansen, 2011), which has been shown to be feasible and effective for use in individuals with MBID (Van der Molen, Van Luit, Van der Molen, Klugkist, & Jongmans, 2010). Further exploring the usefulness and effectiveness of such a training for problematic drinkers with MBID would expand treatment options for problematic drinkers with MBID and address the need for more effective and valid treatment procedures for this target group (Kerr et al., 2013). We therefore advise clinicians to consider neurocognitive assessment in an early phase of the diagnostic and treatment procedure. Broad spectrum measures which cover a wide range of cognitive and/or executive functions (such as standardised test batteries for executive functioning) seem especially useful for this purpose, considering that cognitive dysfunctioning may vary across individuals (Parsons, 1998). However, because our results do not specify if the cognitive deficits in problematic drinkers are temporary or more permanent nor if they are cause or effect of problematic alcohol use, a more thorough study into cognitive deficits in problematic drinkers using a prospective design is warranted.

Footnotes

[1] Because individuals with borderline intellectual functioning (IQ 70–85) often have similar characteristics and caring needs to individuals with mild intellectual disability (IQ 50–70), it is common in The Netherlands to include this target group in research, practice and policy (governmental, policies of insurance companies).

[2] We controlled for booklet number and gender in all analyses, but they had no effect. Therefore, only the results without booklet number and gender as controlling variables are reported.

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General discussion

This chapter is based on:
Van Duijvenbode, N., Didden, R., Korzilius, H. P. L. M., & Engels, R. C. M. E. (submitted).
The usefulness of implicit measures for the screening, assessment and treatment of problematic alcohol use in individuals with mild to borderline intellectual disability.

Substance use (SU) and substance use disorders (SUD) have long been thought to be the outcome of rational decision making (Stacy & Wiers, 2010). However, substance users often do not merely consciously weigh the expected or experienced benefits and costs of SU. According to dual process models of addiction (e.g., Strack & Deutsch, 2004), behaviour is also influenced by automatic, implicit processes. Examples of these implicit processes include the selection and allocation of attention, evaluation of environmental cues and approach/avoidance tendencies towards substances. These processes are considered to be spontaneous, fast, can sometimes occur outside of conscious awareness and cannot easily be controlled. The influence of implicit processes on behaviour can be suppressed if there are sufficient motivation and cognitive resources to do so (Fazio & Olson, 2003). In dual process models of addiction this is pictured as a moderating role of explicit processes in the relationship between implicit processes and behaviour. Explicit processes (such as executive control and motivation) are deliberate, slow and require conscious awareness. As a result of chronic and/or excessive SU the implicit processes become stronger over time while the explicit processes become weaker (Wiers & Stacy, 2006). More specifically, the rewarding effects of substances and related stimuli acquire 'incentive salience', meaning these stimuli seem attractive, 'grab attention' and elicit approach behaviour (Robinson & Berridge, 2008). Problematic substance users have also been shown to interpret ambiguous, substance-relevant stimuli in a substance use-related way (Stacy & Wiers, 2010). These disruptions have been called cognitive biases (i.e., attentional, approach and interpretation biases; Stacy & Wiers, 2010). Similarly, chronic and/or excessive SU has been related to a disrupted inhibitory control system, which is reflected in a smaller working memory capacity, difficulty in delaying gratification and less behavioural control (Hyman, Malenka, & Nestler, 2006). Together, these disruptions indicate a growing loss of control over SU in the development of SUD (Koob, 2013). Although dual process models of addiction have primarily been tested using college students, findings have also been generalised to clinical subjects (e.g., Fadardi & Cox, 2006; Wiers et al., 2014; Woud et al., 2014).

Although the neuropsychological underpinnings of SUD have been studied extensively over the past years, this research has not yet generalised to individuals with mild to borderline intellectual disability (MBID; IQ 50–85; American Psychiatric Association [APA], 2013). It is therefore unknown if the same deficiencies in information processing can be detected in this group, how these deficiencies manifest themselves and if and how these deficiencies differ from those without MBID. In addition to providing a theoretical framework to explain the development and maintenance of SUD, studying the neuropsychological underpinnings of SUD also has potential practical implications for the screening, assessment and treatment of SUD (Stacy & Wiers, 2010; Yücel & Lubman, 2007). It may fulfil the current need for valid screening and assessment tools and effective treatment interventions for SUD in individuals with MBID (Carroll Chapman & Wu, 2012; Kerr, Lawrence, Darbyshire, Middleton, & Fitzsimmons, 2013). We therefore started a

research project aimed at studying the neuropsychological underpinnings of SUD in problematic drinkers with MBID. We focused on (problematic) alcohol use in our studies, because alcohol has been found to be the main substance used and misused by individuals with MBID (To, Neirynck, Vanderplasschen, Vanheule, & Vandevelde, 2014; VanDerNagel, Kiewik, Buitelaar, & De Jong, 2011a). The objectives were to 1) develop and test measures of cognitive biases and executive dysfunction for problematic drinkers with MBID, and 2) study the extent and nature of the influence of IQ and executive control on the cognitive biases by comparing individuals with and without MBID. In this chapter, we first provide a summary of the main findings of this research project and present its general conclusions. In our conclusion, we will focus on the practical implications of our results and the usefulness of implicit measures for the screening, assessment and treatment of SUD in individuals with MBID.

Summary of the main findings

To study cognitive biases in problematic drinkers with MBID, we first created a large database of pictures of alcoholic and non-alcoholic beverages that are sufficiently familiar and simple to study automatic processing (*Chapter 3*). We then adapted two widely used computer tasks (visual dot probe task [VDP], MacLeod, Mathews, & Tata, 1986; approach avoidance task [AAT], Rinck & Becker, 2007) to the needs of individuals with MBID by increasing the number of practice trials, minimising the number of critical trials and building in frequent breaks in between the different blocks of the tasks. In this pilot study, it was concluded that – with the adaptations in the task characteristics – the VDP and AAT can be used in individuals with MBID. Individuals with MBID understood the instructions and IQ did not seem to be associated with the strength or manifestation of the cognitive biases (*Chapter 4*). Using these tasks, we studied the attentional and approach bias in problematic drinkers with MBID. Unexpectedly, however, we found no evidence of the existence of an attentional or approach bias in problematic drinkers. Problematic drinkers did neither respond faster than light drinkers to pictures of alcoholic beverages, nor were they more likely than light drinkers to direct their attention towards pictures of alcoholic beverages or look at these pictures longer than light drinkers (*Chapter 5* and *6*). We did find evidence for an interpretation bias in the same sample of problematic drinkers (*Chapter 7*). Problematic drinkers were more likely to interpret ambiguous, alcohol-relevant situations in an alcohol-related way (see also Ames, Sussman, Dent, & Stacy, 2005; Krank, Schoenfeld, & Frigon, 2010; Woud, Fitzgerald, Wiers, Rinck, & Becker, 2012; Woud et al., 2014). In addition, the activation of this interpretation bias seemed to depend on individual differences in individuals' motivational schema, as we found that drinking motives could predict the strength of the interpretation bias (*Chapter 8*; see also Salemink & Wiers, 2014; Woud, Becker, Rinck, & Salemink, 2015a). With regard to the role of IQ we

found that full scale IQ was not associated with the strength or manifestation of the attentional or approach bias, suggesting that the automatic, implicit processing of visual stimuli might be similar between individuals with and without MBID. Full scale IQ was, however, related to the strength of the interpretation bias, with a relatively strong bias in individuals with MBID.

To study executive and cognitive functioning in problematic drinkers with MBID, we first piloted several measures for executive and cognitive functioning (i.e., Corsi block tapping task, Self-ordered pointing task, Go/No-go task, Stop signal task; *Chapter 9*). Only the Go/No-go task (Newman & Kosson, 1986) and Corsi block tapping task (Corsi, 1972) remained in our later study to measure executive functioning (inhibitory control and working memory capacity) due to difficulties participants with MBID experienced in conducting the other two tasks. Cognitive functioning was measured using the Wechsler Adult Intelligence Scale third edition (WAIS-III; Uterwijk, 2000b). If IQ scores were unknown, cognitive functioning was estimated with a short form of the WAIS-III, which seemed to provide a valid estimate of full scale, verbal and performance IQ in individuals with MBID (*Chapter 11*). Using these tasks, we explored executive and cognitive functioning in problematic drinkers with and without MBID. In contrast with the dual process models we found no executive dysfunctioning in problematic drinkers with and without MBID. Problematic drinkers did not have a smaller working memory capacity and did not show less inhibitory control than light drinkers (*Chapter 10*; see also Ellingson, Flemming, Verges, Barthowos, & Sher, 2014; Fernie, Cole, Goudie, & Field, 2010; MacKillop, Mattson, MacKillop, Castelda, & Donovick, 2007). With regard to cognitive functioning, we also found no differences between light and problematic drinkers in verbal IQ, suggesting that verbal reasoning and vocabulary are relatively intact (see also Bijl, De Bruin, Kenemans, Verbaten, & Böcker, 2005). Problematic drinkers without MBID, however, did show a significantly lower performance IQ compared to light drinkers without MBID. This indicates possible impairments in processing speed, problem solving abilities and cognitive and behavioural flexibility in problematic drinkers without MBID (see also Bravers et al., 2014; Ratti, Bo, Giardini, & Soragna, 2002; Trick, Kempton, Williams, & Duka, 2014). However, problematic drinkers with MBID were not found to have a lower performance IQ compared to light drinkers (*Chapter 12*). Although executive and cognitive functioning were impaired among participants with MBID, we thus found no additive effects of MBID and problematic alcohol use. Nor did we find a moderating role of executive and cognitive functioning on the relationship between the implicit processes and behaviour (see also Pieters, Burk, Van der Vorst, Engels, & Wiers, 2014; Pieters, Burk, Van der Vorst, Wiers, & Engels, 2012; Van Hemel-Ruiter, De Jong, & Wiers, 2011).

In sum, we have reached our objective to develop and test measures of cognitive biases and executive dysfunction for problematic drinkers with MBID. Overall, participants with MBID understood the instructions and were able to conduct the tasks. Our results concerning our second objective – to study the extent and nature of the influence of IQ

and executive control on the cognitive biases by comparing individuals with and without MBID – are mixed and remain inconclusive. Although we did not find attentional or approach biases in problematic drinkers with MBID, we did find an interpretation bias in the same sample. Similarly, although we found no executive dysfunctioning in problematic drinkers, aspects of cognitive functioning did seem impaired. Although IQ was not related to the strength or manifestation of the attentional and approach bias, it did seem to relate to the strength of the interpretation bias. Although executive and cognitive functioning were impaired among both light and problematic drinkers with MBID, we found no additive effects of problematic alcohol use and MBID on executive or cognitive functioning.

Reflection and directions for future research

As explained before, dual process models of addiction theorise that SUD is developed and maintained due to an imbalance between implicit and explicit processes (Strack & Deutsch, 2004). Overall, however, our results do not support dual process models of addiction in individuals with MBID. In this section, we will explore several explanations for our results and will provide several lines for future research. Please note that these explanations are not mutually exclusive and can overlap with each other.

Theoretical considerations

First, dual process models of addiction might be overrated as a theoretical framework for the development and maintenance of SUD. Considering the complex and multifaceted nature of SUD, a biopsychosocial model might be more appropriate to capture the true nature of SUD (*Chapter 2*), because this model emphasises the complex interplay between biological, psychological and social factors that all interact with and influence each other and increase or decrease the risk for developing SUD in a given individual (Donovan, 2005). To illustrate the importance of taking biological, psychological and social factors into account, it has been noted that while SU depends in part on social context (e.g., availability of alcohol in the environment, drinking behaviour of significant others) and conventions (e.g., toasting with a glass of wine, taking a cigarette break), biological and psychological factors contribute to inter-individual differences in vulnerability for developing SUD (Conrad, Pihl, Steward, & Dongier, 2000; Merikanas & McClair, 2012; Wong & Schumann, 2008). Theoretical models such as the dual process models of addiction solely focus on one aspect within the biopsychosocial model, ignoring the interplay between biological, psychological and social factors and thus underestimating the complexity of SUD.

Second, it is possible that the theoretical framework of dual process models themselves do not hold true in problematic drinkers both with and without MBID. Indeed, several

researchers have criticised the theoretical framework of dual process models (e.g., Evans, 2008; Keren & Schul, 2009; Kruglanski & Gigerenzer, 2011). Especially the division of two distinct (but related) processes or systems underlying behaviour and the lack of consensus on how to define those processes or systems have made researchers question the utility of dual process models in the explanation of SUD. They have argued that the two-system model might not be correct and that a uni-system or multiple system model might be more appropriate. In their paper, Kruglanski and Gigerenzer (2011), for example, describe that implicit and explicit processes (or intuitive and deliberate judgement as they call it) are not qualitatively different, but instead are both rule based. Consequently, a unified model of decision making would be more fitting. The critique on the 'conceptual fuzziness' in dual process models could explain the mixed results found in our and other research studies. For example, although several biases have been found in problematic drinkers (e.g., attentional, approach, interpretation and evaluative biases), it is not yet clear how these biases are associated with each other. Also, attentional and approach biases have not uniformly been found in problematic drinkers (e.g., Hobson, Bruce, & Butler, 2013; Vollstädt-Klein, Loeber, Von der Goltz, Mann, & Kiefer, 2009). Similarly, some studies have failed to find evidence for executive dysfunctioning in problematic drinkers (e.g., Ellingson et al., 2014; Fernie et al., 2010) and the moderating role of executive functioning and motivation has also been questioned before (e.g., Pieters et al., 2014; Van Hemel-Ruiter et al., 2011; Van Hemel-Ruiter, Wiers, Brook, & De Jong, in press). We therefore agree with Spruyt et al. (2013) that while studying the neuropsychological underpinnings of SUD will eventually lead to a better understanding of the development and maintenance of SUD, the precise mechanisms in which these neuropsychological processes are related to SU remain unclear.

It should be noted that our results are all based on correlational and cross-sectional studies, which makes it impossible to draw more firm conclusions about the role of cognitive biases and executive dysfunctioning (and the interaction between the two) in the development and maintenance of SUD as described in the dual process models of addiction. It is not clear if the cognitive deficits we found in problematic drinkers without MBID are a cause or rather an effect of problematic alcohol use. It also remains unclear if these cognitive deficits are temporary or permanent. Future studies should consider using a prospective design to address the issue of causality and study the usefulness of the dual process models of addiction more precisely. In future studies, the theoretical framework of dual process models will also need to be studied further, for example by defining the implicit and explicit processes more precisely (e.g., agreeing on terminology, specifying which constructs are included in the model and which constructs therefore define the implicit and explicit processes and specifying the specific features of both implicit and explicit processes; see De Houwer & Moors, 2010; Keren & Schul, 2009), studying the inter-relations between the implicit processes and further studying the way implicit and explicit processes are related.

Individual differences

A more conservative explanation for our results would be that the degree in which the implicit and explicit processes are affected by SUD varies across individuals. In other words, the strength of the cognitive biases and the degree of executive/cognitive dysfunctioning in problematic drinkers could be influenced by personal and contextual factors. This explanation is supported by our data on the attentional and approach biases, which suggested a large variation in the strength of the biases. More specifically, we found that some problematic drinkers showed a bias *towards* alcohol-related pictures, while others showed a bias *away from* alcohol. Indeed, factors such as current levels of craving (Field, Munafo, & Franken, 2009), poly-substance use (Marks, Pike, Stoops, & Rush, 2015), co-morbid psychiatric disorders and the use of psychotropic medication (Sinclair, Nausheen, Garner, & Baldwin, 2010) have been found to influence the strength of the cognitive biases.

It should be noted that the majority of the participants in our studies were diagnosed with one or more psychiatric disorders and often also used cannabis and other drugs in addition to drinking alcohol. Furthermore, most of the participants were prescribed psychotropic medications. Although this co-morbidity between psychiatric disorders, subsequent use of prescribed psychotropic medication and SUD reflects the complex nature of the target group (see for example Center for Substance Abuse Treatment, 2007), a possible influence of these co-morbid disorders on the cognitive biases and executive and cognitive functioning can definitely not be ruled out. The complexity and heterogeneity of our convenience samples thus forms both a strength (representative sample, reflecting the complex and diverse nature of SUD) as well as a weakness of our studies, as the diversity of the participants in, for example, combinations of used substances, type and degree of psychiatric co-morbidity and the type of medication described made it difficult – if not impossible – to disentangle the precise mechanisms in which these factors influenced the strength of the cognitive biases. Contextual factors such as being in treatment might also affect the strength of cognitive biases. Indeed, several researchers have found an *avoidance* of alcohol cues in problematic drinkers (without MBID) receiving treatment (e.g., Noel et al., 2006; Townshend & Duka, 2007; Vollstädt-Klein et al., 2009) possibly as a result of new coping strategies of being confronted with alcohol-related stimuli. It is therefore possible that – as opposed to problematic drinkers not seeking treatment – problematic drinkers undergoing treatment do not show cognitive biases (Field, Marhe, & Franken, 2014).

Research should therefore be directed at explaining individual differences by identifying personal (e.g., drinking motives, alcohol expectancies) and contextual factors (e.g., alcohol use by significant others) that could affect the strength of cognitive biases and the degree of executive/cognitive dysfunctioning. Regarding cognitive biases, one inquiry for future research would be to focus on the context-specific activation of cognitive biases. For example, the activation of the interpretation bias has been shown to be associated with drinking motives. Salemink and Wiers (2014) and Woud et al. (2015a) showed that the level of coping drinking predicted the strength of the interpretation bias

in negative scenarios (e.g., feeling down or stressed), while enhancement and social motives predicted the strength of the interpretation bias in positive scenarios (i.e., a party, being out with friends). This indicates that the interpretation bias is not *always* present but instead is triggered in certain specific situations. Similarly, the activation of the attentional and approach bias might also depend on environmental or situational cues, such as expectations of alcohol use, memories related to alcohol use or alcohol use by significant others. Regarding executive/cognitive dysfunctioning, a first step could be to create a more specific, idiosyncratic profile of cognitive strengths and weaknesses of problematic drinkers to pinpoint more accurately which executive and cognitive functions are affected by SUD and which are not. The use of measures that include a broad range of cognitive functions, such intelligence tests (e.g., the new WAIS-IV; Wechsler, 2012) or standardised test batteries for executive control, is recommended in future studies on this topic.

Psychometric qualities of the measures

A fourth and last explanation for our results concerns the psychometric qualities of the measures we used. In line with results of Schmukle (2005), Ataya et al. (2012a, 2012b), Field and Christiansen (2012) and Kersbergen, Woud and Field (2015) we found the internal consistency of the bias scores to be poor. Cronbach's alpha and the mean inter-item correlation were unacceptably low, suggesting poor item homogeneity and construct validity. This could explain why we found an interpretation bias in problematic drinkers, but no attentional or approach biases in the same group of participants. Research could therefore be directed at improving the psychometric qualities of RT-based tasks, by identifying task parameters that could influence the strength of the biases. Several suggestions for doing so have already been made by other researchers. For example, Miller and Fillmore (2010) suggest using simple rather than complex pictures in studying cognitive biases, while Harrison and McCann (2014) stress the importance of matching the alcohol and neutral picture on parameters such as size and colour. In addition, Price et al. (2014) have provided some recommendations to calculate bias scores and handling outliers in RT (i.e., comparing RTs across neutral/non-neutral and neutral/neutral picture pairs, calculating a bias variability index as a measure of within task fluctuations of strength of the cognitive biases and substituting outliers in RT-data with the highest non-outlying RT). Also, the inconsistent bias scores within a task and across participants might be the result of individual differences in preferences to alcoholic beverages (beer, wine, alcopops and liquor). Fadardi, Cox and Klinger (2006) and Field and Christiansen (2012) have therefore suggested using personalised tasks with individualised stimuli based on drinking preferences. However, such a design would still hamper the comparability between participants and pose challenges regarding determining the exact preferences of participants (e.g., participants without a clear preference, distinguishing participants who prefer a certain type of beverages vs. participants who prefer a certain brand of beverages) that need to be addressed.

In individuals with MBID, the use of RT-based measures was complicated further by a large trial-to-trial, intra-individual variability in RT. Individuals with MBID not only showed a slower overall RT, but their RT also fluctuated within the tasks (see also Deary, Der, & Ford, 2001; Hunt, 2005; Jensen, 2006). This has been associated with a difficulty of individuals with MBID to maintain an optimal level of performance (Baumeister & Kellas, 1968), for example due to momentary fluctuations in attention or deficiencies in executive functioning such as working memory or information processing speed (Haishi, Okuzumi, & Kokubun, 2011; Schmiedek, Oberauer, Wilhelm, Süss, & Wittmann, 2007). A line of research would therefore be to focus on ways to minimise intra-individual variability in RT, for example by studying optimal task and procedural factors to increase the stability of RT. Again, several suggestions for improvement have already been made by other researchers, including providing within-task feedback, using fixed and long preparatory intervals between trials and using simple rather than complex tasks (Dykiert, Der, Starr, & Deary, 2012; Garrett, MacDonalds, & Craik, 2012).

Related to this last explanation is that we merely measured basic executive control functions (e.g., working memory capacity and inhibitory control) to study executive dysfunctioning in problematic drinkers. These basic functions are prerequisites for more complex neurocognitive skills (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000), which are assumed to be affected by chronic and/or excessive alcohol use (Moss, 2008). Future studies might therefore consider using more complex neuropsychological tests in studying executive dysfunctioning in problematic drinkers. Especially the use of virtual reality to study executive functioning might be worth exploring further. Virtual reality uses three-dimensional, ecologically valid – yet controlled – test environments to objectively measure behavioural and neurobehavioural responses (Rizzo & Kim, 2005). Participants often behave as though the environments are real (Rizzo, Schultheis, Kerns, & Mateer, 2004), meaning virtual reality tasks produce a subjective engagement equivalent to real world engagement (Lo Priore, Castelnuovo, Liccione, & Liccione, 2003). Examples of such tasks include the virtual action planning – supermarket (VAP-S; Klinger, Chemin, Lebreton, & Marié, 2004), the virtual library test (VLT; Renison, Ponsford, Testa, Richardson, & Brownfield, 2012) and the virtual store (V-STORE; Lo Priore et al., 2003). Future research could be directed at further piloting these tasks to study executive functioning in problematic drinkers with and without MBID.

A final consideration is that the measures we used to study the implicit and explicit processes are all behavioural measures that provide indirect indications of the underlying neuropsychological processes. As has been recognised previously (e.g., Adinoff & Stein, 2011; Parvaz, Alia-Klein, Woicik, Volkow, & Goldstein, 2011) brain imaging techniques such as nuclear imaging techniques, magnetic resonance imaging techniques and electrophysiological imaging techniques are useful for increasing our fundamental knowledge on the biochemical, electrophysiological and functional processes of the brain associated with SUD and might therefore be especially useful as alternatives for behavioural measures

such as the ones we used. For example, these brain imaging techniques have shed more light on several aspects related to SUD, including craving, loss of control over SU and relapse. More specifically, the application of brain imaging techniques would provide more precise, direct and informative views of the neuropsychological underpinnings of SUD and could therefore supplement or even replace other methods such as self-report and behavioural measures to study the neuropsychology of SUD (Morgenstern, Naqvi, Debellis, & Breiter, 2013). As far as we know, these measures have not yet been used to study SUD in individuals with MBID. Future research in this area is therefore warranted.

Concluding statement

To conclude, this research project has extended our knowledge on the neuropsychological underpinnings of SUD and has shed light on the role of executive and cognitive functioning, thereby improving our understanding of the information processing of light and problematic drinkers with MBID. In our concluding statement, we would like to provide some practical implications that can be translated directly into the day-to-day care of problematic drinkers with and without MBID, including the screening, assessment and treatment of SUD.

First, the large variability in the strength of the attentional and approach bias suggests that there are problematic drinkers (and light drinkers) who *do* show cognitive biases. We advise practitioners to be aware of the possibility of cognitive biases in the information processing of problematic drinkers in their perception and conceptualisation of problematic alcohol use and discuss the potential existence of cognitive biases with clients and/or other caregivers as a component of educating clients about problematic alcohol use (Field et al., 2014).

Second, the large variability in the strength of the attentional and approach bias also suggests that there are problematic drinkers who *do not* show cognitive biases. The use of RT-based measures for clinical purposes such as the screening, assessment and treatment of problematic alcohol use thus has to be discouraged. Considering the problematic psychometric qualities of the measures, we would also discourage the use of these measures in clients who do show cognitive biases The clinical relevance of the (less implicit) word association tasks, on the other hand, looks more promising. For example, these tasks could be incorporated into treatment and relapse prevention interventions as a way to identify high-risk situations for alcohol use or relapse (Woud et al., 2012). In addition, preliminary evidence in problematic drinkers without MBID shows that the interpretation bias can be trained in interpretation retraining procedures, although the effectiveness of such a training in reducing the strength of the interpretation bias and subsequent alcohol use was limited (Woud, Hutschemaekers, Rinck, & Becker, 2015b).

Third, considering the cognitive dysfunctioning in problematic drinkers without MBID, we advise practitioners to consider neurocognitive *assessment* of cognitive and executive functioning in an early phase of the diagnostic and treatment procedure. Identifying executive/cognitive deficiencies improves treatment outcome and success (Copersino et al., 2009) because it allows those with executive/cognitive deficiencies to be entered into treatment interventions more tailored to their needs (McLaughlin, Taggart, Quinn, & Milligan, 2007). For example, it has been suggested that cognitive dysfunctioning often associated with MBID (e.g., attentional dysfunctioning, impaired organisational and planning skills and impaired self-monitoring) hamper the usefulness of treatment programmes based on cognitive and behavioural change (Allan et al., 2012). Identifying such factors in an early phase of the treatment thus guides practitioners in their choices for treatment interventions. In the assessment of executive/cognitive functioning we would recommend to cover a broad range of executive/cognitive functions, because both our (i.e., lower performance but not verbal IQ in problematic drinkers) and other research (e.g., Parsons, 1998) suggests that cognitive and executive deficits vary across participants and represent a diffuse pattern of neuropsychological alterations in the brain. Broad spectrum measures such as intelligence tests or standardised test batteries for executive functioning thus seem especially useful for the purpose of neurocognitive assessment.

Fourth and last, taking into account that we found limited and mixed results regarding executive/cognitive dysfunctioning in problematic drinkers, implementing neurocognitive *treatment protocols* aimed at improving executive/cognitive functioning might not be useful in the treatment of problematic alcohol use at this stage. However, as we did find working memory capacity and inhibitory control to be impaired among individuals with MBID – regardless of the severity of alcohol use-related problems – deficiencies in executive/cognitive functioning should be taken into account in the planning and course of the treatment for this group (see Cunha & Novaes, 2004). For example, concentrating on the long-term positive consequences of cessation might not be effective in individuals with a low working memory capacity and weak inhibitory control, as these treatment goals will be overruled easily when confronted with the positive, short-term consequences of alcohol use (Diamond, 2013). Processing speed could also be taken into account in the planning and course of the treatment, for example by slowing down the pace in treatment protocols, increasing the number of treatment sessions and repeating the same information multiple times to ensure optimal understanding by the client. Our research thus underscores previous findings suggesting that treatment interventions for individuals with MBID must be tailored to their needs (e.g., Degenhardt, 2000; Kerr et al., 2013).

As a whole, this thesis shows that SUD is a complex and multifaceted disorder that is likely to be associated with several neuropsychological disruptions. This thesis has increased our fundamental knowledge on SUD – and, more specifically: the information

processing in problematic drinkers – and has provided more insight into the complex interplay between SUD and MBID. Although we found many similarities between problematic drinkers with and without MBID, we also found some specific factors in problematic drinkers with MBID (i.e., stronger interpretation bias in participants with MBID, larger intra-individual, trial-to-trial variability in RT, no additive effects of MBID and SUD on executive and cognitive functioning), suggesting that problematic drinkers with MBID do in fact form a specific group that can be distinguished from problematic drinkers without MBID. This indicates that SUD requires specialised treatment from multidisciplinary teams with sufficient knowledge of both SUD and MBID. To achieve this, a close collaboration and cross-fertilisation between addiction medicine and ID service providers (amongst others) is vital.

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Samenvatting

Dit hoofdstuk is ingediend als:
Van Duijvenbode, N., Didden, R., Korzilius, H. P. L. M., & Engels, R. C. M. E. (ingediend). *"Het zit allemaal tussen mijn oren!" De neuropsychologie van verslavingsproblematiek bij mensen met een licht verstandelijke beperking.*

In de afgelopen jaren is de aandacht voor alcoholgebruik en alcoholproblematiek bij mensen met een lichte verstandelijke beperking (LVB, IQ 50–85, American Psychiatric Association [APA], 2013) sterk toegenomen. Waar eerder nog werd aangenomen dat alcoholgebruik bij deze mensen nauwelijks voorkomt, is de heersende opvatting nu dat zij over het algemeen meer en ernstigere negatieve gevolgen ervaren van alcoholgebruik dan mensen zonder een LVB (Slayter, 2008) en juist een risicogroep vormen voor het ontwikkelen van alcoholproblematiek (Burgard, Donohue, Azrin, & Teichner, 2000; McGillicuddy, 2006). Desondanks is de (fundamentele) kennis over alcoholproblematiek bij mensen met een LVB beperkt en ontbreekt het grotendeels aan valide screening- en diagnostische instrumenten en effectieve behandelvormen (*Hoofdstuk 2*). Clinici in zowel de verstandelijk gehandicaptenzorg als in de verslavingszorg geven bovendien aan over onvoldoende vaardigheden te beschikken om deze groep adequaat te begeleiden en behandelen (McLaughlin, Taggart, Quinn, & Milligan, 2007). Hierdoor krijgen mensen met een LVB en alcoholproblematiek vaak niet de vereiste gespecialiseerde zorg en kunnen zij onvoldoende profiteren van het behandelaanbod (Burgard et al., 2000; Degenhardt, 2000). Er is daarom grote behoefte aan meer onderzoek naar alcoholproblematiek bij mensen met een LVB, waaronder meer fundamentele kennis over alcoholproblematiek en het ontwikkelen van nieuwe, valide screening- en diagnostische instrumenten en effectieve behandelvormen (Carroll Chapman & Wu, 2012; Kerr, Lawrence, Darbyshire, Middleton, & Fitzsimmons, 2013).

In 2011 is Trajectum daarom in samenwerking met het Behavioural Science Institute van de Radboud Universiteit een onderzoeksproject gestart naar de neuropsychologie van alcoholproblematiek bij mensen met een LVB. Dit onderzoek richtte zich op het in kaart brengen van verstoringen in het beloningssysteem en informatieverwerkingssysteem van de hersenen en zou niet alleen bijdragen aan de theorievorming over het ontstaan en voortbestaan van alcoholproblematiek, maar ook bijdragen aan de ontwikkeling van nieuwe mogelijkheden voor het screenen, diagnosticeren en behandelen van alcoholproblematiek bij deze doelgroep. Dit is een samenvatting van het onderzoeksproject. Na een korte uiteenzetting van het theoretisch kader, presenteren wij de belangrijkste bevindingen van het onderzoek. Tot slot zullen wij ingaan op de praktische implicaties ervan voor de screening, diagnostiek en behandeling van verslavingsproblematiek bij mensen met een LVB.

Theoretisch kader

Volgens de DSM-5 (APA, 2013) is één van de centrale kenmerken van verslavingsproblematiek (zoals alcoholproblematiek) een aanhoudend verlangen naar het gebruik van het middel en een onvermogen het middelengebruik te minderen of te stoppen, ondanks (kennis hebben van) de negatieve lichamelijke, psychische en sociale problemen die

ermee gepaard gaan. Wiers en Stacy (2006, p. 292) hebben dit de "paradox van verslaving" genoemd.

Met behulp van duale procesmodellen (bijv. Bechara, Noel, & Crone, 2006; Strack & Deutsch, 2004; Wiers et al., 2007) is geprobeerd deze paradox te verklaren. Hoewel de terminologie verschilt tussen de duale procesmodellen, hebben ze met elkaar gemeen dat zij veronderstellen dat gedrag wordt beïnvloed door twee semi-onafhankelijke systemen, namelijk een reflectief en een impulsief systeem (zie Figuur 1). Het impulsieve systeem wordt gekenmerkt door snelle, automatische denkprocessen en beoordelingen, zoals aandacht voor en waardering van stimuli in de omgeving. Deze processen treden spontaan en soms buiten het bewustzijn op en zijn niet eenvoudig te controleren. Het reflectieve systeem daarentegen omvat tragere, gecontroleerde denkprocessen die ontstaan uit bewuste overwegingen, regels en verwachte resultaten. Voorbeelden hiervan zijn executieve functies, emotieregulatie en motivatie. Volgens duale procesmodellen modereert het reflectieve systeem de relatie tussen het impulsieve systeem en gedrag. Dit wil zeggen dat mensen met sterke executieve functies beter in staat zouden zijn om langetermijndoelen actief in gedachten te houden, impulsen die in strijd zijn met deze doelen te onderdrukken en verschillende strategieën toe te passen om conflicten tussen impulsen en langetermijndoelen op te lossen (Stacy, Ames, & Knowlton, 2004; Wiers & Stacy, 2006). Hoewel IQ niet wordt beschreven in duale procesmodellen, kan dus worden verondersteld dat het impulsieve systeem een grotere invloed heeft op het gedrag bij mensen met zwakke executieve functies – zoals mensen met een LVB (Willner, Bailey, Parry, & Dymond, 2010a) – in vergelijking met mensen met sterke executieve functies.

Als gevolg van structurele veranderingen in onder andere het belonings- en informatieverwerkingssysteem van de hersenen, raakt het impulsieve systeem hypergevoelig voor de belonende eigenschappen van alcohol en drugs (en stimuli die daaraan gerelateerd zijn). Er ontstaan hierdoor cognitieve vertekeningen (*biases*) in automatische processen zoals het richten en vasthouden van de aandacht, automatische actietendensen en interpretatie en associatie (Stacy & Wiers, 2010). Langdurig middelengebruik gaat bovendien gepaard met een verzwakt reflectief systeem, wat zich bijvoorbeeld uit in verstoringen in executieve functies zoals het werkgeheugen, gedragsinhibitie en uitstel van directe behoeftebevrediging (Dackis & O'Brien, 2005; Hyman, Malenka, & Nestler, 2006). Dit betekent dat het gedrag in toenemende mate wordt gestuurd door automatische processen die buiten het bewustzijn plaatsvinden en moeilijk te controleren zijn. Deze verdere afname van executieve functies zou kunnen verklaren waarom mensen met een LVB een hoger risico hebben op het ontwikkelen van verslavingsproblematiek na initieel middelengebruik.

Naast een theoretisch kader voor het ontstaan en voortbestaan van verslavingsproblematiek, heeft onderzoek naar de neuropsychologie van verslaving ook belangrijke praktische implicaties voor de screening, diagnostiek en behandeling (Stacy & Wiers, 2010; Yücel & Lubman, 2007). Zo zou de ernst van de cognitieve vertekeningen een maat

kunnen zijn voor de ernst van de verslavingsproblematiek. Omdat cognitieve vertekeningen bovendien lijken af te nemen als gevolg van behandeling, zou de sterkte van deze vertekeningen bij aanvang van de behandeling een voorspeller kunnen zijn van het effect van de behandeling terwijl de afname in sterkte van de cognitieve vertekeningen zou kunnen dienen als maat voor behandeleffect. Ook zouden cognitieve vertekeningen direct kunnen worden verminderd door zogenaamde 'cognitieve bias modificatie', waarbij mensen worden getraind hun aandacht te verschuiven van middelengerelateerde naar neutrale stimuli, alcohol en drugs te associëren met negatieve stimuli of alcohol en drugs te vermijden door middel van het wegduwen van een joystick. Tot slot zou de diagnostiek en behandeling zich kunnen richten op het reflectieve systeem, door bijvoorbeeld de motivatie voor verandering of de executieve functies te verbeteren door middel van training. Aangezien maten voor cognitieve vertekeningen en executieve functies niet afhankelijk zijn van taalvaardigheden, minder gevoelig zijn voor sociale wenselijkheid en over het algemeen gemakkelijk uit te voeren zijn, zouden ze vooral nuttig kunnen zijn in de behandeling voor mensen met een LVB.

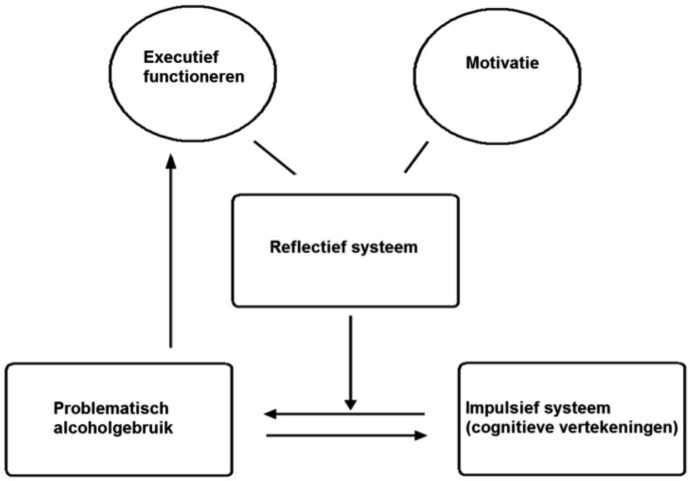

Figure 1 Het duale procesmodel (aangepast van Houben, Schoenmakers, Thush, & Wiers, 2008).

Samenvatting van de resultaten

Cognitieve vertekeningen

De eerste stap in het onderzoeken van cognitieve vertekeningen bij problematisch drinkers met een LVB was het creëren van een grote database van plaatjes van alcoholische en non-alcoholische dranken (*N* = 255). Deze plaatjes werden herkend door zowel lichte als problematisch langdurig abstinente drinkers met en zonder een LVB (*N* = 40) en waren eenvoudig van aard (een glas, blikje of flesje tegen een witte achtergrond), waardoor ze gebruikt kunnen worden om automatische processen te kunnen bestuderen (*Hoofdstuk 3*). In een pilotstudie zijn vervolgens twee veelgebruikte computertaken om vertekeningen in aandacht (*visual dot probe task*; MacLeod, Mathews, & Tata, 1986; Figuur 2a) en automatische actietendensen (*approach avoidance task*; Rinck & Becker, 2007; Figuur 2b) te meten, aangepast aan de doelgroep van mensen met een LVB. Dit is gedaan door de instructies zo eenduidig en eenvoudig mogelijk te maken, een relatief lange oefensessie in te bouwen voorafgaand aan de daadwerkelijke uitvoering van de taak en het regelmatig aanbieden van een pauze tijdens de taak. Uit deze pilot bleek dat de (aangepaste) computertaken geschikt zijn voor onderzoek bij mensen met een LVB: zij begrepen de instructies, ervoeren geen moeilijkheden bij het uitvoeren van deze instructies en vonden de taken over het algemeen plezierig om te doen (*Hoofdstuk 4*).

Met behulp van deze taken zijn vertekeningen in aandacht en automatische actietendensen onderzocht bij lichte en problematisch drinkers met en zonder een LVB (*Hoofdstuk 5* en *6*). Tegen de verwachting in vonden wij geen aanwijzingen voor het bestaan van vertekeningen in aandacht en automatische actietendensen bij problematisch drinkers. Problematisch drinkers reageerden niet sneller op plaatjes van alcoholische dranken, waren niet meer geneigd hun aandacht te richten op plaatjes van alcoholische dranken en keken ook niet langer of meer naar deze plaatjes dan lichte drinkers (zie Hobson, Bruce, & Butler, 2013; Vollstädt-Klein, Loeber, Von der Goltz, Mann, & Kiefer, 2009 voor vergelijkbare resultaten). Opmerkelijk was echter wel dat de sterkte van de cognitieve vertekeningen binnen de groep problematisch drinkers sterk varieerde: sommige problematisch drinkers waren sterk *gericht* op alcohol, terwijl anderen alcohol juist *vermeden*. Wij bieden twee mogelijke verklaringen voor deze resultaten. Allereerst kan deze variatie in sterkte van cognitieve vertekeningen worden veroorzaakt door individuele verschillen in bijvoorbeeld mate van trek of zucht (Field, Munafo, & Franken, 2009), poly-gebruik (Marks, Pike, Stoops, & Rush, 2015), comorbide psychiatrische stoornissen en het gebruik van psychofarmaca (Sinclair, Nausheen, Garner, & Baldwin, 2010) en het al dan niet volgen van verslavingsgerelateerde behandeling (Field, Marhe, & Franken, 2014). Onderzoek heeft namelijk laten zien dat deze factoren de sterkte van de cognitieve vertekeningen kunnen beïnvloeden. Een tweede verklaring voor de grote variatie in sterkte van cognitieve vertekeningen betreft de psychometrische kenmerken van de computertaken. In lijn met andere onderzoekers (bijvoorbeeld Ataya et al., 2012; Field &

Christiansen, 2012; Kersbergen, Woud, & Field, 2015) vonden wij namelijk dat de interne consistentie van de bias scores slecht was. Dit betekent dat de sterkte van de cognitieve vertekeningen binnen één persoon, binnen één taak sterk varieerde. Dit beperkt de

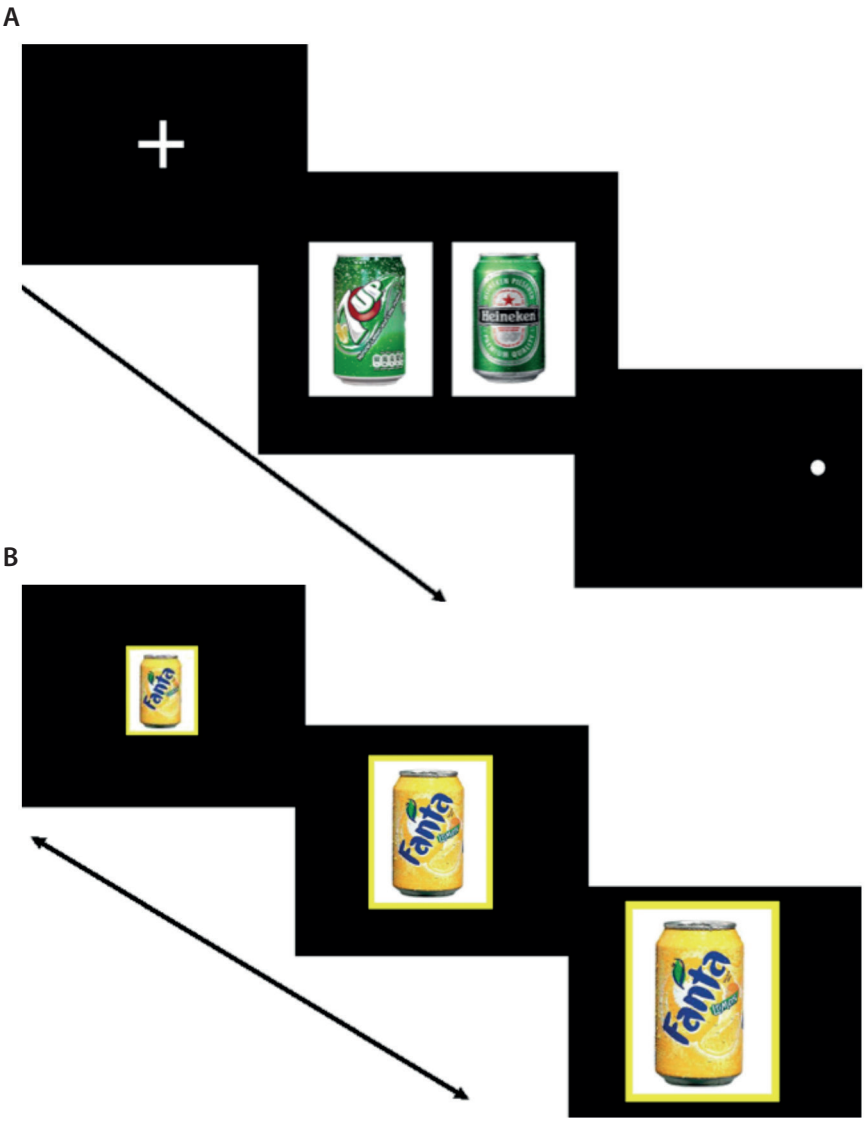

Figure 2 Schematische weergave van (**A**) de visual dot probe task (MacLeod et al., 1986) en (**B**) de *approach avoidance task* (Rinck & Becker, 2007).

betrouwbaarheid en validiteit van de computertaken, wat vervolgens consequenties heeft voor de praktische bruikbaarheid ervan.

Met betrekking tot de rol van IQ vonden wij dat IQ niet geassocieerd was met de sterkte van de cognitieve vertekeningen. Dit suggereert dat automatische, impliciete verwerking van visuele stimuli vergelijkbaar is tussen mensen met en zonder een LVB. Opvallend was echter dat IQ wel van belang leek in de uitvoering van de taak. Mensen met een LVB hadden namelijk niet alleen een lagere reactiesnelheid, maar lieten ook meer variantie in hun reactiesnelheid zien binnen de taak (zie ook Deary, Der, & Ford, 2001; Hunt, 2005; Jensen, 2006). Dit wordt ook wel intra-individuele variabiliteit in reactiesnelheid genoemd en wordt in verband gebracht met een onvermogen om een optimaal prestatieniveau vast te kunnen houden (Baumeister & Kellas, 1968), bijvoorbeeld als gevolg van fluctuaties in aandacht of beperkingen in executieve functies zoals het werkgeheugen en de informatieverwerkingssnelheid (Haishi, Okuzumi, & Kokubun, 2011; Schmiedek, Oberauer, Wilhelm, Süss, & Wittman, 2007). Wat dit betekent voor de bruikbaarheid, validiteit en betrouwbaarheid van maten gebaseerd op reactietijd, zoals de computertaken die wij hebben gebruikt, is vooralsnog onbekend.

Interpretatiebias

Naast vertekeningen in aandacht en automatische actietendensen laten problematisch drinkers ook een zogenaamde interpretatiebias zien. Dit wil zeggen dat zij (meer dan lichte drinkers) geneigd zijn ambigue woorden, situaties of scenario's op een alcoholgerelateerde manier te interpreteren (zie bijvoorbeeld Ames, Sussman, Dent, & Stacy, 2005; Krank, Schoenfeld, & Frigon, 2010; Woud, Fitzgerald, Wiers, Rinck, & Becker, 2012; Woud et al., 2014). De interpretatiebias wordt gemeten met woordassociatietaken, waarin participanten worden gevraagd hun eerste, spontane reactie te geven bij het horen of lezen van een woord of scenario (zie Tabel 1). Met behulp van een dergelijke woordassociatietaak is de interpretatiebias bij lichte en problematisch drinkers met en zonder een LVB onderzocht. In lijn met eerder onderzoek vonden wij dat problematisch drinkers significant meer alcohol-gerelateerde antwoorden gaven op de scenario's dan lichte drinkers (*Hoofdstuk 7*). In een tweede studie naar dit onderwerp bleek bovendien dat drinkmotieven de sterkte van de interpretatiebias in positieve en negatieve scenario's kon voorspellen (*Hoofdstuk 8*). Coping motieven (alcohol drinken om negatieve gevoelens te reduceren of reguleren) voorspelde de sterkte van de interpretatiebias in negatieve scenario's. Dit impliceert dat deze mensen een associatieve relatie hebben gevormd tussen onplezierige gevoelens (stress, angst, boosheid), alcoholgebruik en spanningsreductie door herhaaldelijk alcohol te drinken bij negatieve gebeurtenissen. Wanneer zij dus met dergelijke gebeurtenissen worden geconfronteerd (zoals in de woordassociatietaak), worden hun alcohol-gerelateeerde geheugenschema's geactiveerd, wat de kans op alcoholgebruik in deze situaties vervolgens vergroot. Zowel coping motieven als sociale motieven voorspelden de sterkte van de interpretatiebias in positieve scenario's.

Dit betekent dat mensen die alcohol drinken om sociale situaties leuker te maken of om het aangaan van sociale relaties te verbeteren de neiging hebben om positieve scenario's (zoals een feestje of festival) te associëren met alcoholgebruik (zie ook Salemink & Wiers, 2014; Woud, Becker, Rinck, & Salemink, 2015a).

Met betrekking tot de rol van IQ werd gevonden dat zowel lichte als problematisch drinkers met een LVB een relatief sterke interpretatiebias hadden in vergelijking met mensen zonder een LVB. De verklaring voor deze resultaten is speculatief. Mogelijk zijn mensen met een LVB gevoeliger voor suggestieve vragen, waardoor zij meer geneigd waren antwoorden te geven in overeenstemming met de doelen van het onderzoek dan mensen zonder een LVB (Finlay & Lyons, 2001, 2002). Een tweede verklaring is dat alcohol-gerelateerde schema's meer toegankelijk en geactiveerd waren bij mensen met een LVB dan bij mensen zonder een LVB. De sterkte van de interpretatiebias in neutrale scenario's (die niet of nauwelijks kunnen worden geassocieerd met alcoholgebruik) correleerde namelijk negatief met IQ. Beide verklaringen zijn echter speculatief en dienen getoetst te worden in toekomstig onderzoek.

Tabel 1 Voorbeelden van positieve, negatieve en neutrale scenario's van de woordassociatietaak (Woud et al., 2012) en mogelijke antwoorden van participanten.

	Scenario	**Mogelijke antwoorden**
Positief scenario	**Filmavond** Filmavond bij je vriend. "Nog eentje?", zegt één van je maatjes. De verleiding is groot en je pakt een …	Nieuwe film Glas Biertje
Negatief scenario	**Rotdag** Het is een verschrikkelijke dag en alles gaat mis. Je wilt dit rotgevoel kwijt en jezelf troosten. Je krijgt ontzettend zin in …	Chocola Een drankje Alcohol
Neutraal scenario	**Avondje pokeren** Om de week speel je poker met je vrienden. Alles is voorbereid en de kaarten worden verdeeld. Deze keer zijn jouw kaarten heel erg …	Goed Slecht Moeilijk om mee te winnen

Executief en cognitief functioneren

Om het reflectieve systeem bij lichte en problematisch drinkers met en zonder een LVB te onderzoeken is allereerst een pilotstudie uitgevoerd, waarin de bruikbaarheid van verschillende gecomputeriseerde maten voor executief functioneren (werkgeheugencapaciteit: *Corsi block tapping task, Self-ordered pointing task;* inhibitie: *Go/No-go task, Stop signal task;* uitstel van directe behoeftebevrediging: *Delay discounting task*) werd getoetst. Uit deze eerste pilottaak bleek dat er bij langdurig abstinente, voorheen problematisch drinkers met en zonder een LVB geen sprake was van beperkingen in het executief functioneren (*Hoofdstuk 9*). In onze latere studie hebben wij alleen gebruik gemaakt van de *Go/No-go task* (Newman & Kosson, 1986; Figuur 3a) en de *Corsi block tapping task* (Corsi, 1972; Figuur 3b) vanwege moeilijkheden die mensen met een LVB ervoeren in het uitvoeren van de overige taken. Cognitief functioneren werd gemeten met de derde editie van de *Wechsler Adult Intelligence Scale* (WAIS-III-NL; Uterwijk, 2000b). Bij het ontbreken van IQ-gegevens in het dossier van de participant, werd IQ geschat met behulp van een verkorte versie van de WAIS-III, die bestond uit vier subschalen (Woordenschat, Overeenkomsten, Blokpatronen, Matrix redeneren). Deze verkorte versie bleek een valide schatting te geven van het totaal, verbaal en performaal IQ van mensen met een LVB (*Hoofdstuk 11*).

Met behulp van deze taken werd het executief en cognitief functioneren bij lichte en problematisch drinkers met een LVB onderzocht. In tegenstelling tot de verwachtingen vonden wij geen beperkingen in het executief functioneren bij problematisch drinkers met en zonder een LVB: problematisch drinkers hadden geen kleinere werkgeheugencapaciteit en hadden ook niet meer moeite met gedragsinhibitie dan lichte drinkers (*Hoofdstuk 10*). Hoewel dit in tegenstelling tot de duale procesmodellen is, zijn de resultaten naar executief functioneren bij problematisch drinkers niet eenduidig en hebben enkele andere onderzoeken evenmin bewijs gevonden voor executief disfunctioneren bij deze doelgroep (Ellingson, Flemming, Verges, Barthowos, & Sher, 2014; Fernie, Cole, Goudie, & Field, 2010; MacKillop, Mattson, MacKillop, Castelda, & Donovick, 2007). Met betrekking tot het cognitief functioneren vonden wij geen verschillen tussen lichte en problematisch drinkers in verbaal IQ, wat suggereert dat verbaal redeneren en woordenschat relatief intact zijn (zie ook Bijl, De Bruin, Kenemans, Verbaten, & Böcker, 2005). Problematisch drinkers zonder een LVB hadden echter een significant lager performaal IQ in vergelijking met lichte drinkers zonder een LVB. Dit wijst op mogelijke beperkingen in de verwerkingssnelheid, het probleemoplossend vermogen en flexibiliteit in problematisch drinkers zonder een LVB (zie ook Bravers et al., 2014; Ratti, Bo, Giardini, & Soragna, 2002; Trick, Kempton, Williams, & Duka, 2014). Bij problematisch drinkers met een LVB bleek het performaal IQ echter niet significant lager te zijn dan bij lichte drinkers met een LVB (*Hoofdstuk 12*). Hoewel problematisch alcoholgebruik dus gepaard lijkt te gaan met beperkingen in het executief en cognitief functioneren, lijkt er geen sprake te zijn van een verdere afname in het executief en cognitief functioneren bij problematisch drinkers met

een LVB. Een andere mogelijke verklaring is dat het patroon van beperkingen in het executief en cognitief functioneren bij problematisch drinkers sterk verschilt tussen personen (Parsons, 1998), iets wat wij met deze maten onvoldoende hebben kunnen onderzoeken.

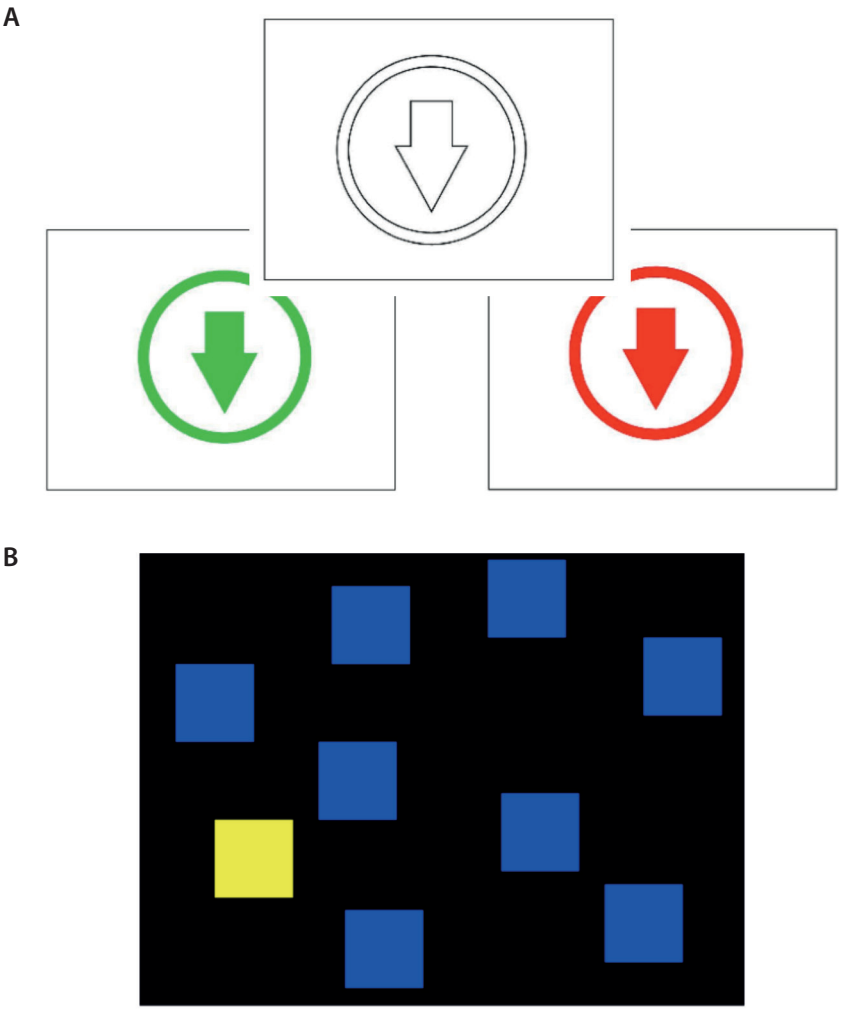

Figure 3 Schematische weergave van (**A**) de *Go/No-go task* (Newman & Kosson, 1986) en (**B**) de Corsi block tapping task (Corsi, 1972).

Klinische implicaties

Dit onderzoeksproject heeft meer kennis opgeleverd over de neuropsychologie van verslavingsproblematiek bij mensen met een LVB. In *Hoofdstuk 13* worden de praktische implicaties van onze resultaten voor de screening, diagnostiek en behandeling van verslavingsproblematiek bij mensen met een LVB beschreven.

Een eerste implicatie voor de praktijk is dat behandelaren zich bewust dienen te zijn van het bestaan van cognitieve vertekeningen bij hun cliënten. Ons onderzoek heeft immers laten zien dat de sterkte van de cognitieve vertekeningen sterk uiteenloopt tussen problematisch drinkers, wat betekent dat er een subgroep bestaat die deze vertekeningen inderdaad laat zien. Wij adviseren behandelaren hier daarom rekening mee te houden in hun perceptie en conceptualisatie van verslavingsproblematiek en de mogelijkheid van het bestaan van cognitieve vertekeningen met hun cliënten (en verwanten) te bespreken in het kader van bijvoorbeeld psycho-educatie (Field et al., 2014).

De grote variabiliteit in de sterkte van de cognitieve vertekeningen betekent echter ook dat er een subgroep problematisch drinkers is die *geen* cognitieve vertekeningen in aandacht en automatische actietendensen heeft. Mede gezien de problematische psychometrische kenmerken van de computertaken, raden wij daarom het gebruik van impliciete maten zoals de *visual dot probe task* (MacLeod et al., 1986) en de *approach avoidance task* (Rinck & Becker, 2007) voor klinische doeleinden vooralsnog af. De klinische relevantie van woordassociatietaken is daarentegen rooskleuriger. Deze taken zouden bijvoorbeeld kunnen worden ingezet in de terugvalpreventie, omdat zij risicovolle situaties voor alcoholgebruik of een terugval in alcoholgebruik op een laagdrempelige manier zouden kunnen identificeren (Woud et al., 2012). Een tweede toepassing van de woordassociatietaken in de praktijk is het hertrainen van automatische interpretaties, alhoewel de effectiviteit hiervan in een eerste onderzoek bij problematisch drinkers zonder een LVB beperkt was (Woud, Hutschemaekers, Rinck, & Becker, 2015b). Verder onderzoek hiernaar wordt daarom aanbevolen.

Een derde aanbeveling voor de praktijk is dat behandelaren in een vroeg stadium van de behandeling een uitgebreid neuropsychologisch onderzoek uitvoeren. Onze resultaten (*Hoofdstuk 12*) wijzen immers op enkele beperkingen in cognitief functioneren bij problematisch drinkers zonder een LVB in de vorm van een lager performaal IQ. Door beperkingen in het executieve of cognitieve functioneren in een vroeg stadium te ontdekken, kan het behandeltraject meer toegesneden worden op de individuele behoeften van de cliënt (McLaughlin, Taggart, Quinn, & Milligan, 2007). Zo kunnen problemen met het vasthouden van aandacht, verminderde organisatorische en planningsvaardigheden en lagere mate van zelfcontrole bijvoorbeeld de toepasbaarheid van behandelprogramma's gebaseerd op cognitieve en gedragsverandering beperken (Allan et al., 2012). Door neuropsychologisch onderzoek kunnen behandelaren dus een

gerichtere keuze maken voor behandelinterventies, wat het resultaat van de behandeling uiteindelijk kan verbeteren (Copersino et al., 2009). In de neuropsychologische diagnostiek wordt bovendien aangeraden een breed spectrum aan functies te onderzoeken om op die manier tot een individueel sterkte/zwakte profiel te komen. Dit wordt aangeraden omdat zowel ons als eerder onderzoek (Parsons, 1998) heeft laten zien dat het sterkte/zwakte profiel bij problematisch drinkers sterk uiteenloopt. Daarom lijken uitgebreide, gestandaardiseerde testbatterijen en intelligentie tests het meest geschikt voor dit doeleinde.

Tot slot, in tegenstelling tot neuropsychologisch onderzoek in de diagnostiekfase van de behandeling is het invoeren van neuropsychologische behandelinterventies in de aanpak van verslavingsproblematiek momenteel te voorbarig. In ons onderzoek vonden wij immers geen beperkingen in het executief functioneren van problematisch drinkers. Het cognitief functioneren was bovendien alleen en deels beperkt bij problematisch drinkers zonder een LVB. Omdat onze resultaten echter ook lieten zien dat lichte en problematisch drinkers met een LVB beperkingen in executieve functies hebben, dient dit voor deze doelgroep wel meegenomen te worden in de planning en het verloop van het behandelcontact (Cunha & Novaes, 2004). Bij mensen met een kleine werkgeheugencapaciteit en beperkte gedragsinhibitie zal het bijvoorbeeld niet zinvol zijn de behandeling te concentreren op abstracte langetermijndoelen, omdat deze behandeldoelen gemakkelijk uit het oog verloren kunnen worden wanneer iemand wordt geconfronteerd met de positieve, korte termijn gevolgen van middelengebruik (Diamond, 2013). Ook verwerkingssnelheid zou in overweging moeten worden genomen in de planning en het verloop van het behandelcontact. Zo zou de frequentie en het aantal behandelcontacten vergroot moeten worden, zal informatie gedoseerd gegeven moeten worden en zal informatie bovendien meerdere keren herhaald moeten worden voor optimaal begrip. Ons onderzoek bevestigt daarmee het belang dat behandelinterventies moeten worden aangepast aan de specifieke kenmerken en behoeften van mensen met een LVB (Degenhardt, 2000; Kerr et al., 2013).

Conclusie

Samenvattend onderstreept dit onderzoeksproject de complexiteit van verslavingsproblematiek bij mensen met een LVB. De afzonderlijke studies hebben laten zien dat verslavingsproblematiek bij mensen met een LVB gepaard lijkt te gaan met allerlei neuropsychologische verstoringen in het belonings- en informatieverwerkingssysteem van de hersenen. Alhoewel er veel overeenkomsten werden gevonden tussen problematisch drinkers met en zonder een LVB, vonden we ook enkele verschillen. Zo vonden we een sterkere interpretatiebias bij mensen met een LVB, vonden we geen (verdere) afname van executief en cognitief functioneren bij problematisch drinkers met een LVB en vonden we

dat mensen met een LVB een grotere intra-individuele variabiliteit lieten zien in hun reactietijd. Dit suggereert dat problematisch drinkers met een LVB als een specifieke doelgroep kan worden gezien die zich op verschillende vlakken onderscheidt van problematisch drinkers zonder een LVB. Dit geeft aan dat de diagnostiek en behandeling van verslavingsproblematiek bij deze doelgroep een gespecialiseerde aanpak vereist van multidisciplinaire teams die zowel voldoende kennis hebben over het hebben van een LVB als van de diagnostiek en behandeling van verslavingsproblematiek. Samenwerking tussen de sectoren van de geestelijke gezondheidszorg (zoals de verslavingszorg en de verstandelijk gehandicaptenzorg) is daarom van essentieel belang.

Dankwoord

You've worked so hard and come so far. Now look what's ahead: a finish line with your name on it. Only the final stretch awaits you…

De laatste woorden van mijn proefschrift. De woorden waar ik lang naar heb uitgekeken, maar misschien ook wel de moeilijkste woorden om te schrijven. Er zijn zoveel mensen die op enig moment en op enige manier hun steentje hebben bijgedragen aan dit proefschrift, hoe kan ik hen ooit bedanken…

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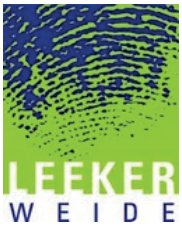
LEEKER
WEIDE


ARDUIN
voor mensen door mensen


Brijder
verslavingszorg


trajectum
Hanzeborg en Hoeve Boschoord


IPSE DE BRUGGEN


IRISZORG
DICHT BIJ MENSEN, VER IN ZORG


Aveleijn


Koraal Groep


omnizorg


Pluryn


Tactus
verslavingszorg

About the author

Curriculum Vitae

Neomi van Duijvenbode was born on March 25, 1987 in Leiden (the Netherlands). After completing her secondary education at the Andreas College, Pieter Groen in Katwijk in 2005, she studied Psychology at the University of Utrecht, where she specialized in clinical and health psychology and followed several extra-curricular courses in criminology and forensic psychology. During her master's program, she completed a six-month clinical internship at forensic psychiatric centre Oldenkotte and conducted research on the prevalence and characteristics of institutional aggression among forensic psychiatric patients. After receiving her master's degree in February 2011, she became passionate about improving mental health care by practice-based scientific research, collaboration and sharing knowledge – both nationally and internationally. She therefore tries to integrate clinical practice, research and education in her professional career.

Neomi continued to work as a psychologist at the intensive care unit of the forensic psychiatric centre Oldenkotte. In 2013, she switched to working as a psychologist at Aveleijn – intellectual disability care – where she supervised the daily care and treatment of clients with an intellectual disability, sometimes in combination with co-occurring physical, psychiatric and psychosocial problems. Her clinical experience lies at the interjection of forensic psychiatry, addiction medicine and care for individuals with an intellectual disability, as her expertise is the care and treatment of clients with a dual or triple diagnosis (intellectual disability + psychiatric disorder + substance use disorder).

Simultaneously, she started her PhD research at the Behavioural Science Institute of the Radboud University and in collaboration with Trajectum in February 2011. Her research project focused on the neuropsychological underpinnings of substance use disorder in (young) adults with mild to borderline intellectual disability (this thesis). As a PhD candidate, she presented her research at ten national and four international conferences, attended multiple workshops and followed several courses. She also regularly published book chapters and research articles on substance use (disorder) in individuals with mild to borderline intellectual disability (see Publications).

As part of her PhD research she also gained teaching experience: she gave several lectures and classes and supervised a substantial number of bachelor and master students in conducting their dissertation. She obtained her basic teaching qualification (BKO) in November 2015 and has continued her teaching at the Faculty of Social Sciences of the Radboud University, where she now gives classes for the course Professional Skills for Psychologists for bachelor students.

Neomi is currently working as a senior researcher at Pluryn, where she continues to study substance use (disorder) in adults with mild to borderline intellectual disability. Other areas of interest include cognitive and executive functioning of (young) adults with mild to borderline intellectual disability, staff – client communication and aggressive behaviour by (young) adults with mild to borderline intellectual disability and challenging behaviour.

Publications

This dissertation

Van Duijvenbode, N., Didden, R., Korzilius, H. P. L. M., & Engels, R. C. M. E. (submitted). *Attentional bias in problematic drinkers with mild to borderline intellectual disability.*

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